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CATARACT
AND ITS TREATMENT

HENRY KIRKPATRICK

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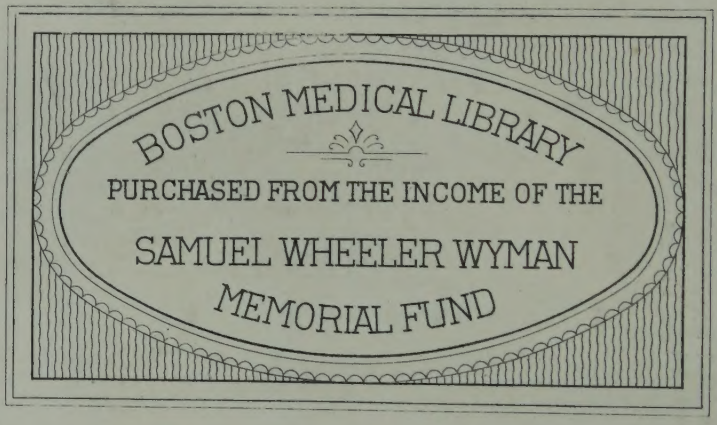
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CATARACT
AND ITS
TREATMENT

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CATARACT
AND ITS
TREATMENT

BY

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PREFACE

Cataract is, perhaps, the disease of the eye which has the greatest interest for the ophthalmic specialist. The result of surgical interference is usually highly satisfactory both to the patient and to the operator ; at the same time, great variation of detail in the proceeding is permissible, and the surgeon is allowed free scope for his individuality. It is therefore not surprising that the treatment of the disease presents a peculiar fascination. Doubtless, in course of time, this will cease to be purely surgical, for, when we have learned the causes of each type of cataract, we shall be in a better position to prevent the formation of opacities in the lens, and to render them stationary once they have developed.

Much work has been done on the subject of cataract during the past few years, and in this book an attempt has been made to place before the reader, in a condensed form, some of those observations that appear of most importance.

The civil surgeon in India is called upon to deal with many cases of cataract, and the general work and the popularity of his hospital may often be greatly increased by his success in treating the disease ; he also has exceptional opportunities to investigate the circumstances which influence the causation of cataract, and to develop methods of treatment. He is, however, handicapped in that, owing to transfers and other reasons, it is usually difficult for

him to maintain a library to which he can turn for information regarding points that concern the lens in health and in disease. I trust that this book may be of service to him in this respect, as an endeavour has been made to record in it the observations of different authorities.

It would be difficult for me to acknowledge adequately my debt to Lt.-Col. R. H. Elliot for the help he has so freely given me by his invaluable suggestions, for permitting me to use the illustrations from his books, and for assistance in many respects. My acknowledgments are also due to the Editor and the Editorial Committee of the *British Journal of Ophthalmology* for leave to use the photographs of Barraquer's operation, to Mr. Herbert Parsons for kindly allowing the reproduction of figures from his book on the *Pathology of the Eye*, and to Mr. Treacher Collins for permitting the use of illustrations from his papers. Messrs. Weiss & Co. and Mr. Clement Clarke have kindly helped me by furnishing illustrations of instruments. Mr. Burdon Cooper has most generously placed some of his notes at my disposal. Lastly, my thanks are due to the staff of the Madras Government Ophthalmic Hospital for the careful manner in which they have recorded the notes of my cases operated upon in that Institution ; they have thus enabled me to form an opinion on the respective merits of different methods of operation and of treatment.

H. KIRKPATRICK.

54 Welbeck Street, London.

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CHAPTER I

DEVELOPMENT, ANATOMY, AND NUTRITION OF THE LENS

The three stages of development — Formation of lens-star — Composition of lens—Lens capsule—Anatomy of Lens—The zonule —Lens growth—Nutrition of lens.

The Development of the Lens may be divided into three stages :

1. The first stage extends up to the closure of the lens vesicle in the fourth week of intra-uterine life. The earliest sign of lens development is a thickening of the ectoderm overlying the secondary optic vesicle. The next event is an invagination of the thickened area into the anterior part of the cup, formed by the secondary optic vesicle, and a hollow lens vesicle is thus formed. The lens vesicle is lined by ectodermic cells, and is, at first, open towards the surface, but closure of its anterior wall and separation from the surface take place at the end of this stage.

2. The second stage runs from the fourth week, up to the time when, in the second month of fœtal life, the entire cavity of the vesicle becomes filled by the forward growth of the cells lining its posterior wall. During this period, the proximal cells, or those which lie behind the equator of the lens vesicle, elongate and grow forward in a sagittal direction until they reach the layer of cells lining the

anterior wall of the vesicle. The entire cavity of the vesicle is thus filled, and the space, which formerly existed between the anterior and posterior walls, is abolished. These cells, derived from the posterior wall of the vesicle, form the earliest lens fibres, and persist during the whole of life as the most central part of the fully developed lens. All these lens fibres run in an antero-posterior direction.

3. The third stage occupies the period between the abolition of the cavity of the lens vesicle and birth. During it, lens growth takes place as the result of the proliferation of the cells which lie in and just posterior to the equatorial region of the vesicle. These cells lengthen out anteriorly and posteriorly. The new fibres are arranged concentrically around those formed in the second stage of development, so that they push the latter away from the walls of the lens vesicle. The formation of lens fibres in this stage is thus similar to that which occurs throughout life. The rapidity of growth diminishes, however, as age advances, since the activity of the cells is checked by the increasing intracapsular tension. The fibres, formed in the later part of this stage, are not sufficiently long to reach from pole to pole of the vesicle, and their extremities, therefore, meet along lines, or sutures, which radiate from each pole. At birth these sutures usually form a triradiate figure, the three limbs meeting at the pole and forming three angles of 120° (Fig. 1).

The figure at the posterior pole is similar to that at the anterior, but is placed in relation to it as if the whole figure had been rotated through an angle of 60° ; consequently, if a limb of either figure is produced meridionally round the lens, it will bisect the corresponding angle of the other figure or lens-star. The surfaces of the lens are, in this way, usually divided into three main sectors at birth.

As fresh layers of lens fibres are laid down, this simple arrangement of the lens-star becomes more complicated. Secondary rays branch off from each primary ray, and several lens sectors are thus formed. These sectors are often apparent in the adult lens, and are best

displayed by focal illumination. The pattern of the lens-star is by no means the same in each individual, but on the contrary shows considerable variation.

The older lens fibres, during the growth of the lens throughout life, are being constantly surrounded by successive layers of new lens tissue, which are formed by the proliferation of the equatorial capsular cells. Since the old fibres can neither be desquamated nor absorbed, they become compressed together in the centre of the lens. The young lens fibres are long,

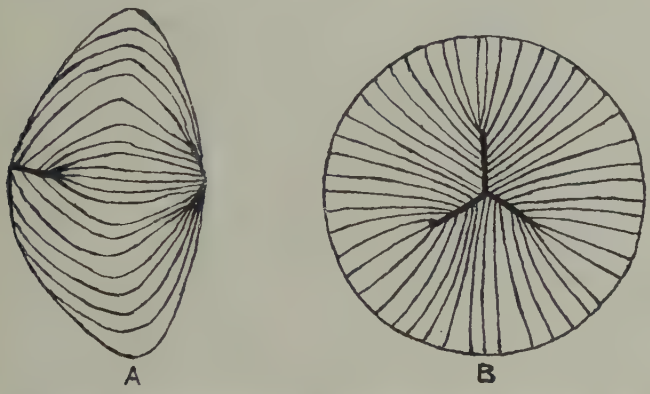

FIG. 1.—Diagram to represent the arrangement of the lens fibres around a fœtal triradiate lens-star. A, profile view of lens, showing the equatorial region; B, view of anterior surface. The diagram represents the arrangement of the fibres in one of the many layers of the lens.

flat, six-sided, prismatic, nucleated bands which run meridionally from a suture line of the anterior lens-star to a corresponding suture line of the posterior lens-star; as their age increases, they lose their nuclei, become narrower, and are more closely approximated. The margins of the oldest fibres are crenated, and may sometimes be dentated. The condensed fibres form a firm mass, or nucleus, in the centre of the lens; this nucleus increases in size and in density throughout life.

If the lens of an infant or of a very young person is removed from the eye, it will be found to be composed of

clear, colourless, sticky fibres which are enclosed in a thin, transparent envelope or capsule. In the case of a person of middle age or more, if the lens is squeezed between the finger and thumb, the membranous capsule will rupture and the firm, yellow nucleus will escape, leaving the young, glutinous, cortical fibres behind ; further pressure will evacuate the transparent, sticky, cortical matter.

The Lens Capsule.—Most authorities now agree that the capsule of the lens is of ectodermic origin, and that it is the result of the activity of the cells of the lens vesicle. Its reactions to digestive processes resemble those of ectodermic structures, and differ from those of connective-tissue origin. The facts (1) that the capsule increases in thickness during extra-uterine life, and (2) that the increase of its anterior layer is greater than that of its posterior layer also suggest that it is a product of the epithelial cells. Schirmer has minutely studied the capsule, and has demonstrated the existence of a lamellar structure. It is probable that the capsule of the lens begins to form at a very early stage in the development of the lens vesicle.

The capsule of the healthy adult lens is a transparent elastic membrane, and is about 0·016 mm. thick at the anterior pole and 0·008 mm. thick at the posterior pole (Ritter). The anterior layer of the capsule is lined by epithelial cells, but the posterior layer is devoid of such lining and is in direct contact with the fibres of the lens. The capsular cells of the equatorial region elongate and form the lens fibres. Mlle Toufesco describes three different kinds of cells which line the anterior layer of the capsule : (1) large, clear, central cells with intercellular bridges—these seem to play a fundamental rôle in the nutrition of the lens ; (2) small peripheral cells with numerous long prolongations—these seem to be charged with the defence of the lens against external influences ; (3) equatorial cells, disposed in meridional series, which form fibres and seem to be charged with the regeneration of the lens.

Fibro-vascular Sheath of the Lens.—During the time

in fœtal life when the growth of the lens is most active, the lens cells are nourished by a plexus of vessels arranged around the capsule. The posterior portion of this sheath derives its blood-supply from the central hyaloid artery, and the anterior portion from the anterior ciliary arteries. The part of the vascular sheath which lies in the region of the pupil is called *the pupillary membrane*, and traces of this may frequently be found in the adult eye (Fig. 8). Portions of a persistent pupillary membrane may be distinguished by the fact that they spring from the anterior surface of the iris. The vascular sheath of the lens disappears during the last two months of fœtal life.

Anatomy of the Lens.—The lens is a bi-convex structure having an anterior and a posterior surface, and an anterior and a posterior pole. The equator of the lens lies at the junction of its two surfaces, and is included between the two main layers of the lens ligament or zonule of Zinn. The antero-posterior diameter of the lens, according to Fuchs, is 5 mm. and the transverse diameter 9 mm. The size of the lens will, however, vary according to age, etc., and the antero-posterior diameter will alter with accommodation. Professor Arthur Thomson found the average sagittal diameter to be 3·02 mm. and the coronal to be 8·6 mm. Priestley Smith found the sagittal diameter occasionally to measure as much as 6 mm., and even 6·5 mm. The same writer found the coronal diameter to vary from 8·67 mm. in the third decade of life to 9·62 mm. in the ninth decade. The diameters showed a regularly graduated increase with age.

During repose, the anterior surface of the lens forms a curve whose radius is 10 mm., and the posterior surface forms a curve whose radius is 6 mm. The posterior surface thus shows a greater convexity than the anterior. The posterior surface of the lens is embedded in the fossa patellaris of the vitreous body. Opinions differ as to whether the fossa patellaris is lined by an extension of the hyaloid membrane or not; but clinical evidence, derived from experience of removal of the lens in its capsule, would certainly suggest that it is so.

The lens, contained in its capsule, lies within the corona ciliaris, or ring formed by the ciliary processes, being held in position by the zonular ligament or zonule of Zinn. The lens and its ligament thus form a barrier between the aqueous and vitreous chambers. Whilst the posterior surface of the lens lies in the fossa patellaris, the central part of its anterior surface is in contact with the pupillary margin of the iris.

Professor Arthur Thomson states that the front of the middle part of the lens is separated from the central point of the inner surface of the cornea by a distance of from 2 to 3 mm., the average being 2·2 mm., and that the equatorial axis of the lens lies 2·4 mm. behind the limbal ring, or the external sclero-corneal junction. The same writer estimates the circumlental space, or the distance between the equator of the lens and the ciliary processes, to be 1 mm., whereas Fuchs reckons it to be 0·5 mm.

The Zonule.—Most observers now consider that the zonule has a mesodermic origin. Some of its fibres arise as far back as the ora serrata and, passing forward in close relationship to the surface of the ciliary body, join other fibres which originate from the region of the ciliary processes ; these latter appear to spring in greater number from the valleys between the processes, so that the zonular fibres are grouped in well-defined bundles. The fibres are divided into two main sheets, the anterior of which passes across the circumlental space to be attached along a fairly abrupt margin to the surface of the lens capsule in front of the equator, whilst the posterior is similarly attached behind the equator (Thomson). Terrien describes delicate, intermediary fibres, which subdivide the intervening area. These fibres bifurcate before their insertion into the equatorial region of the capsule. Eugenio Aguilar describes the arrangement of the insertion of zonular fibres into the anterior capsule as follows : " Strong bundles of fibres, varying in length and number, arise from the ciliary processes and from the depressions between them. The shortest and stoutest end near the edge of the capsule, but send on longer fibrils to be inserted lower

down. The longer bundles begin to divide and break up as they pass from the tips of the ciliary processes on to the capsule." The insertion of the fibres covers the periphery of the capsule for a distance equal to one-eighth of the transverse diameter of the lens. The circumlental space between the two layers of the zonule is called the canal of Petit. The walls of the canal are, however, incomplete, and, owing to the interlacement of fibres that occurs, no clear lumen of the canal exists.

Professor Arthur Thomson describes the circumference of the lens as being toothed and irregular, owing to the strain exercised by the pull of the zonular fibres, and states that the equator of the lens does not correspond to a linear strip coinciding with the summit of its greatest width, but harmonises with a somewhat broad and flattened zone, which intervenes between the anterior and the posterior lamellæ of the suspensory ligament.

Many observers have recorded the fact that the suspensory ligament has a very much weaker attachment to the lens in the senile than in the youthful eye. This has an important bearing on the question of extraction of the lens in its capsule.

Lens Growth.—All observers agree that the lens steadily increases in size during the life of the individual. Such an increase is to be expected when it is considered that the lens is unable to exfoliate the older fibres from its centre, whilst new fibres are being constantly added to the periphery of the structure. It is quite possible that the growth of the lens is not absolutely regular and continuous, and that, in certain conditions of general health, it may be retarded or may even cease. This is suggested by the irregularities which can sometimes be observed in the level of the nuclei of the fibres in the nuclear zone. The grooving of the nails, which is seen to follow a severe illness, is an instance of an interference with the growth of an allied tissue.

Priestley Smith, examining 156 lenses obtained post-mortem, found a uniform increase with age in the weight, volume, and diameter of 127 of these lenses which were

free from cataract. The specific gravity, however, showed little alteration. The following table shows the results obtained by him :

Age.	A Weight Mg.	B Volume Cub. Mm.	C Spec. Grav.	D Diameter. Mm.
20 to 29 . .	174	163	1067	8·67
30 to 39 . .	192	177	1085	8·96
40 to 49 . .	204	188	1085	9·09
50 to 59 . .	221	205	1078	9·44
60 to 69 . .	240	225	1067	9·49
70 to 79 . .	245	227	1078	9·64
80 to 90 . .	266	244	1090	9·62

N.B.—Above the age of 69 the number of transparent lenses examined was much smaller than in the earlier decades.

Similar results have been obtained by other observers.

The Nutrition of the Lens.—The following facts in connection with the nutrition of the lens are of importance : (1) The lens is a purely passive structure, and its nutritive requirements are consequently exceedingly limited ; (2) its tissue is non-vascular, and it must therefore obtain its nutriment from the fluids which surround it ; (3) its fibres are hygroscopic, imbibing fluid very readily, and such imbibition leads to a loss of transparency ; (4) the lens substance is protected by a capsular membrane which is devoid of anatomical pores.

The lens obtains its nourishment by osmosis, mainly from the aqueous humour, through the lens capsule—the cells upon the surface of the ciliary body probably being the chief source of the aqueous.

The percentage of salts contained in the aqueous is very similar to that contained in the blood serum, but the latter contains about 8 per cent. of albumin against about 2 per cent. contained in the normal aqueous. Nuel has found that the osmotic pressure of the aqueous and vitreous is the same as that of the blood, and Roemer states that the physiological fluctuations of the osmotic pressure of the

blood serum are continually transmitted to the intra-ocular fluid, and that the lens is adapted to these fluctuations. He has also found that a salt solution which corresponds in concentration to the osmotic pressure of the blood serum is the best isotonic solution for the lens. There is, however, some difference of opinion regarding this point, and Collins and Mayou consider that "the composition of the lens and the surrounding fluid differ considerably during life, so that osmosis does not take place according to the ordinary law of diffusion. The cells lining the capsule must evidently have some selective power. After their death the ordinary law of diffusion does assert itself, and the composition of the lens and aqueous tend to approximate." Parsons, too, states that "the chemical composition of the lens differs materially from that of the aqueous : it is therefore obvious that some protective influences are at work to prevent an approximation of osmotic and other physical processes. These are to be found in all probability in the capsule and its lining epithelium."

It is worthy of note that, although antibodies may be greatly increased in the serum after immunisation, yet only traces of these appear in the intra-ocular fluid as long as the tunics of the eye remain intact ; the ciliary body therefore has the power to prevent the passage of such substances into the intra-ocular fluid. The lens is protected from cytotoxins in the same way, and Roemer suggests that this phenomenon should be called the law of cytotoxin retention by the secretory apparatus of the eye.

Diffusion into the substance of the lens takes place extremely slowly. Bence Jones has shown that substances, introduced into the circulation, enter the lens the last of any part of the body, and that, once entry has been effected, excretion is correspondingly delayed.

Leber considers that the lens fibres, which are in need of nutrition, draw their supply from all places where the nutriment has access to the lens. Experiments seem to show that diffusion is most free at the equator in the region of the suspensory ligament, where cell growth is most active. Staining of the lens fibres in this area has

been observed by Deutschman, who immersed the lens of an iodised rabbit in a solution of palladium chloride, and by others who used ferrocyanide of potassium and an alcoholic solution of chloride of iron in their experiments. Injection of fluorescine has yielded similar results. The predilection which progressive opacities show for the equatorial region of the lens, suggests either that this part receives a proportionately greater supply of toxic substances, should these be present in the intra-ocular fluids, or that it is most sensitive to the deprivation of nutriment when this is deficient. Since the epithelium is generally admitted to exercise a selective influence upon the substances passing into the lens tissue, it is likely that diffusion occurs over the whole area of the anterior layer of the capsule. The observation of Mlle Toufesco, that degenerative changes in the capsular epithelium precede the occurrence of lenticular opacities, is evidence in support of the view that diffusion takes place in this region.

It is possible that some nutritive matter may also enter the lens substance by way of the posterior layer of the capsule, but that this occurs to any great extent is shown to be unlikely by the fact that this layer of the membrane has no epithelial lining, and that injury to this part of the capsule does not always lead to the formation of a progressive opacity ; local opacity of the lens, too, from this cause, is sometimes only of a temporary character. It is probable that the nutritive matter reaches the lens fibres along the paths formed by the intercellular cement.

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CHAPTER II

HISTOLOGICAL, PHYSICAL, AND CHEMICAL CHANGES IN THE CATARACTOUS LENS

The nature of a cataract—Histological changes in cataractous lenses—Changes in volume and weight—Water content—Ash residue—Chemical changes.

A CATARACT is an opacity of the lens (*lenticular cataract*), or of the capsule (*capsular cataract*), or of both structures (*lenticulo-capsular cataract*). The opacity is due to the degeneration of the lens fibres or of the capsular cells, or to the growth of these in an abnormal manner.

Histological Changes.—When progressive cataract develops, the most striking early histological change is the appearance of fissures between the cortical fibres ; this change has been considered by many writers to be due to an excessive shrinking of the older fibres. Fluid, which coagulates into small spheroidal bodies, called "Morgagnian globules," collects in the clefts. The lens fibres next undergo degeneration, becoming cloudy and distorted, whilst the cell nucleus becomes vesicular and the whole fibre eventually breaks up into fatty globules, called myelin droplets. The fissures gradually increase in size, and, coalescing, form spaces which are filled by a fluid containing a mixture of albuminous Morgagnian globules, fat drops, fatty and other crystalline deposits, and débris. The changes are usually first observed in the region of the equator, but the whole of the cortex becomes involved later. When degeneration of the cortex is nearly complete, the fibres lose their attachment to the capsule, a thin layer of fluid frequently forming between their

extremities and the membrane. This constitutes the stage of "maturity," and the cataract is said to be "ripe," as the cortex can then be readily removed from the capsular envelope, since it is no longer adherent to the membrane. As the degenerative changes progress, water may be either added to or abstracted from the altered cortex. In the first case swelling occurs, and, when the stage of hypermaturity is reached, the cortex is converted into a milky fluid which surrounds the lens nucleus (Morgagnian cataract). The nucleus itself is seldom free from change in such circumstances, as it not only becomes discoloured, but also very frequently undergoes partial absorption and becomes smaller in size. This change is unaccompanied by any erosion of the nuclear surface, which is usually very smooth and rather polished. When water is absorbed from the cataractous cortex, inspissation occurs, and the degenerated cortical matter undergoes shrinkage and, in the stage of hypermaturity, is converted into a very firm crust. Calcification of the inspissated matter may occur if hypermaturity has lasted for a long time.

It is rare for the nuclear fibres to undergo such a degenerative change as would result in the formation of an opacity, and this is only likely to occur in early life or in the case of a secondary cataract. The nucleus, in cataract, is, however, seldom free from staining, the degree of which may vary from an amber to black. This phenomenon has been attributed by Burdon-Cooper (p. 16) to the oxidation of tyrosin; spectroscopic analysis shows that blood pigment is not the cause of the coloration. Staining of the nucleus is considerably more pronounced in the senile cataracts of Indians than in those met with in England.

Changes in the capsule are liable to occur in most varieties of cataract, and may sometimes represent the earliest pathological alteration in the progressive forms of the disease. Some of the cells, which line the anterior layer of the capsule, may become vacuolated, and this change is often accompanied by the deposit of hyaline material, and so leads to the formation of hyaline nodules and

patches. The cells become large, swollen, and vesicular, and their shape becomes spherical or, in some cases, from the effect of pressure, polygonal. Collins and Mayou attribute these changes to a diminution of intracapsular tension. A double row of capsular cells is sometimes found, and an abnormal proliferation of the cells in the equatorial region may occur and lead to the formation of an epithelial lining to the posterior layer of the capsule. The growth of cells and the hyaline thickening may cause the formation of dense masses in the capsule of a hypermature cataract. The capsular thickenings are most extensive in those cataracts in which inspissation of the degenerated cortex has occurred, and are usually only represented by small discrete spots in the case of Morgagnian cataracts as long as the Morgagnian fluid remains in any quantity. Calcification of the capsular deposits may occur in the later stages of hypermaturity. In some cases of Morgagnian cataract the capsule becomes denuded of epithelium ; the probable cause of this change is either that the lining cells have undergone an excessive degree of degeneration, or that they have been absorbed by the action of enzymes, or that they have been mechanically stripped from their attachment by the free movements of the lens nucleus ; it is likely that the causes are frequently combined. Such a change appears to favour a spontaneous cure by absorption of the opaque fluid (p. 58).

Physical Characteristics of the Senile Cataractous Lens.—Considerable difference of opinion exists between various observers as to the physical changes that occur in the progressive cataracts of old age. This may be ascribed to the fact that the observations recorded have not been made upon the same type of senile cataract in every case, and that the amount of water, absorbed by or abstracted from the degenerated lens matter, varies greatly.

Volume.—Priestley Smith states that the cataractous lens is of smaller volume than the healthy lens of the same age. Herbert found that " some of the cataractous lenses of the liquefying type, either Morgagnian or less advanced, were distinctly swollen beyond the extreme normal limit

by the imbibition of aqueous." Clinical experience amply shows that the volume of senile cataractous lenses varies greatly in different cases, and that this is sometimes larger and sometimes smaller than that of the normal lens of the same age. The shallow anterior chamber, unconnected with high tension, seen in many cases of Morgagnian cataract, is evidence of an increase in the size of the lens.

Weight of cataractous lens.—W. J. Collins states that the lens affected by senile cataract is lighter than the clear lens of the same age. Clapp has also found the weight of the cataractous lens to be less than that of the clear lens.

Water content of cataractous lens.—Contradictory opinions have been expressed regarding the percentage of water contained in lenses affected by cataract. Deutschman considered that a decrease in the water content of the lens occurred with age, and that this change was more marked in the cataractous lens than in the normal one. Becker claimed that senile cataractous lenses contain considerably more water than unclouded senile lenses. W. J. Collins stated that the cataractous lens contains less water than the normal lens. Dor considered that the old lens contains less water than the youthful one, but that the percentage of water is increased in cataract.

Ash residue.—W. J. Collins found that the cataractous lens contained more solids and ash than the normal one. Burge found less organic material and a lower percentage of ash in the cataractous lens as compared with the healthy one.

Chemical Changes.—Cahn and others have noted that cataractous lenses contain an excess of fat, lecithin, and cholesterin. W. E. Burge, in a very valuable paper on the analysis of ash of normal and cataractous lenses, obtained both from India and the United States, comes to the following conclusions :

" 1. There is a decrease of potassium in the cataractous lens from 38·8 per cent. of the ash in the normal to 9·8 per cent. in cataract.

" 2. The calcium in the cataractous lens increases from an almost negligible quantity in the normal to 12·5 per cent. in cataract.

" 3. There is an increase in the magnesium in the cataractous lens obtained in the United States from 1·2 per cent. as estimated in the pig's lens to 8 per cent. This increase is therefore not so marked as the increase in the calcium.

" 4. Assuming that the sodium in the normal pig lens is about the same in quantity as the sodium in the normal human lens, then the increase in sodium is practically of the same extent as the decrease in the potassium, the sodium increasing from 6·67 per cent. in the normal to 25·06 per cent. in the cataractous condition.

" 5. The lenses obtained from India differ from those obtained from the United States, in that they contain a large amount of calcium, potassium, and possibly sodium silicate, and fail to show any increase in the percentage of magnesium in the ash."

The same observer has made the extraordinarily interesting observation that in cases of cataract, which he was able to produce experimentally by the action of light rays of short-wave length combined with the presence of inorganic salts in solution, sodium chloride was increased in the case of nuclear cataract, and calcium chloride was increased in the case of cortical cataract.

Burdon-Cooper observed the presence of tyrosin in the aqueous after having performed a discission operation for high myopia, and subsequently found the same substance in a great many other cases of progressive cataract, so that he was " satisfied that where the lens was cataractous, tyrosin was present in it, and also in the aqueous humour." He found that tyrosin was most abundant in the aqueous of such cataractous patients as suffered from albuminuria. Burdon-Cooper found that he could obtain nearly pure tyrosin on hydrolysing lens matter by warming a portion of the human lens in a test-tube with 2 per cent. sulphuric acid, and that on oxidation by an alcoholic extract of a fungus—Russula nigricans—the tyrosin altered in colour through progressively deeper shades of amber to black, the depth of colour depending upon the degree of oxidation. He concludes that the coloration of the lens in black

cataract is due to the oxidation of the amino-acid which is produced by the hydrolysis of the lens albumin. Coats reports the finding of a substance resembling the associated amino-acid leucin in a cataractous lens, and gives references to other cases in which leucin has been found.

Considering the relationship of the lens cells to those of the epidermis, and the sclerosis of the older fibres which takes place, it is a little surprising that keratin is not a constituent either of the normal or of the cataractous lens. Knies has proved the absence of this substance from the lens by means of Kuhne's digestive method.

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CHAPTER III

ÆTIOLOGY OF CATARACT

Congenital cataract—Progressive cataract—Exposure to glare—Cataract in India—Errors of refraction—Senility—General debilitating conditions—Diabetes—Cholera—Hypothyroidism—Hypoparathyroidism—Naphthalin poisoning—Ergot poisoning—Diminished renal permeability—Hereditary predisposition—Autocytotoxic theory—Influence of senility, diabetes, toxæmias, and diet deficiencies upon the function of the endocrine glands.

The cause of partial, non-progressive cataract must be one which is active for a limited period only. Its influence is exerted only upon the lens cells which at the time are in process of growth into fibres, and degeneration of these occurs in consequence. After the cause of the degeneration has ceased to act, the affected fibres become buried in the substance of the lens by the formation of healthy fibres between their surface and the capsule, a change which occurs as a result of the natural growth of the lens. Such cataracts are found in early life during the years when cell growth is very active, when noxious influences are more likely to be transitory, and when recovery of the organs of the body from injury is easier and more rapid. Such deleterious conditions may affect the embryonic lens cells *in utero*, and may be due to defects of maternal nutrition as well as to hereditary influences. Congenital cataract is thus caused either by a disturbance of development or by an intra-uterine inflammation of the eye (Fuchs). Hess and others have drawn attention to the importance of defective closure of the lens vesicle, and Treacher Collins has pointed out the part played by defective development of the posterior capsule in the causation of some forms of congenital cataract.

In the case of progressive cataract the cause may be local or general, or both. When purely local it is usually fairly obvious, and cataracts, of such origin, are often complicated. The opacity, when of local origin, is frequently due to an alteration in the nutrition of the lens fibres, which is caused by an interference with the functions of the capsule. *Trauma, lightning stroke, inflammatory exudations on the capsule, retinal detachment, and intra-ocular tumour* are examples of conditions which act directly on the capsule. The lens changes induced by *retino-choroiditis* and by *glaucoma* are probably due to the effect of alterations in the aqueous humour brought about by these diseases. Excessive exposure to glare and errors of refraction are minor local causes which are unlikely to cause the formation of a cataract unless they are associated with a general constitutional defect. The frequent occurrence of senile cataract in the tropics, the liability of furnace-workers and glass-blowers to the disease, and the result of Burge's experiments on the effect on the lens of rays of short-wave length, suggest, however, that *exposure to excessive glare* may sometimes be a factor in the causation of progressive cataract.

The question whether senile cataract is really more common in India than it is in Europe is not quite so simple as might at first sight appear. The large numbers dealt with by individual surgeons in the East would suggest that cataract must undoubtedly be more common in that part of the world, but it should be remembered that the population is a large one and that the number of competent surgeons is comparatively small, so that a surgeon in the East draws his cases from a much wider field than does his confrère in Europe ; yet, after making due allowance for this, it would certainly appear that senile cataract really is more common in the tropics than it is in temperate climates. The Census Report of India for 1901 states : " The prevalence of blindness is to a great extent determined by climate, where the glare and dust are highly prejudicial to the eyesight, and is comparatively rare in a cool or damp country, where a profusion of vegetation

rests the eye, and where there is a comparative absence of dust." Elliot states that he has met with a proportion of cataract, amongst retired Anglo-Indians, that strongly suggests that residence in the East influences the liability to the disease.

It is probable that exposure to heat and glare is not the sole reason why cataract is more common in India. *Gastro-intestinal disturbances and oral sepsis* are widespread in the tropics, and most observers must have been struck by the frequent association of these conditions with incipient cataract in India. The Indian, too, matures at an earlier age than the European and, as a rule, he pays for this by an earlier occurrence of the retrogressive tissue changes due to senility; these changes are shown in the lens by a comparatively early appearance of presbyopia, and by the fact that the accommodative power of a middle-aged Indian is rarely equal to that of a European of the same age. The researches of Burge and Neill would appear to show that exposure to light rays of short-wave length is in itself insufficient to cause lens opacity, but that it will do so if certain salts (magnesium chloride, sodium silicate, calcium chloride, and dextrose) are present in the aqueous in an abnormal quantity.

Errors of refraction have been said to predispose to cataract; but, since the development of cataract is so often accompanied by a change in the refraction of the lens, it is difficult to estimate their responsibility for the disease. It cannot be denied, however, that incipient lenticular opacities may often be observed in patients who are suffering severely from asthenopic symptoms, and that these opacities are often more developed in the eye which shows the greater error of refraction; in very rare instances, too, a small opacity may disappear after the refraction has been suitably corrected. It is possible that, should a constitutional cause for the disease exist, even in a small degree, the presence of an uncorrected error of refraction may be sufficient to induce the formation of a lens opacity in the affected eye. An eye, the subject of an error of refraction, appears to be specially liable to the ocular

complications of diabetes, nephritis, and focal sepsis, and, if this be so, it is only to be expected that such an eye would be exceptionally susceptible to cataract formation, should a constitutional cause of the disease be present.

Lenticular opacities sometimes occur in connection with high myopia. Such opacities often progress very slowly, and may remain stationary for long periods.

The fact that the occurrence of uncomplicated, progressive cataract is so seldom limited to one eye indicates that its cause must usually be sought for in some constitutional and general change or defect. *Senility* is the most common associated general condition, and the sclerosis of the lens fibres, which occurs with the advance of years, forms the basis of the theories advanced by Magnus and by Becker to account for the occurrence of cataract. Magnus considered that the resistance to the flow of nutritive fluid, offered by the sclerosis of the nucleus, was an important factor, and Becker supposed that an unequal and irregular sclerosis produced a stress and strain upon the cortical fibres which led to the formation of clefts and spaces between them. When considering the consequences of sclerosis, it must be remembered, however, that, although opacities are present in the lenses of very many people who are advanced in years, yet the proportion of old people affected by progressive cataract is not very high. Obviously, since sclerosis of the lens invariably occurs with the advance of age, and progressive cataract does not do so, this hardening of the lens cannot be considered to be the chief cause of senile cataract. This must be looked for in some other more general condition, which is associated with senile changes in the organs of the body. The fact that the opacities of senile cataract may often be observed to make rapid progress during or just after periods of temporary illness, and to remain nearly stationary whilst the general health is exceptionally good, is evidence to this effect.

The observations of Priestley Smith upon 156 lenses, obtained post-mortem, show the influence of senility on the causation of cataract. "Between the ages of 20

and 49 no single instance of any opacity was met with among the sixty-six lenses examined. Between 50 and 59 two lenses out of twenty-two, *i.e.* 9 per cent., presented the earliest signs of cataract in the form of slight cortical opacities at the equator. Between 60 and 69 nine out of thirty-two, *i.e.* 28 per cent., were affected similarly or to a greater extent. Between 70 and 90 thirty-four lenses were examined, and of these no less than sixteen, *i.e.* nearly 50 per cent., were affected in like manner."

Cataract has been said to follow many *debilitating general conditions*, such as the acute infective fevers and chlorosis, and it has frequently been observed to occur after an attack of *cholera* ; its close association with *diabetes* has been long recognised. Convulsions of the kind found in *tetany* have often been found to precede the formation of a cataract (Zirm has observed six such cases to occur within four months, and many others have recorded similar instances of the same thing). A history of infantile convulsions may frequently be obtained in cases of lamellar cataract, the association of which disease with rickets, and with a deficient development of the enamel of the teeth, has been noted by many observers. Ormond found lens opacities to be present in 50 per cent. of Mongolian idiots at Earlswood and Darenth. Rowe Jeremy reports a case of double cataract in a Mongolian infant, and quotes Stoelzner as stating that Mongolism in the child is due to hypothyroidism in the mother and child. Fischer and Triebenstein examined sixty-eight cases of senile and presenile cataract, and claim to have found evidences of tetany and latent tetany in 88·2 per cent. of such cases against a percentage of 8·3 in twelve controls. Noël Paton and Findlay's observations suggest that the parathyroids detoxicate a guanidine compound derived from muscular metabolism, and that, if this is not removed, tetany is the result. Parathyroidectomy produces changes in the hair and nails, and causes delayed and imperfect calcification of the teeth, all of which structures have an ectodermic origin similar to that of the lens ; in addition to causing tetany, the operation also appears to diminish

the activity of bone growth and to delay the healing of fractures, so that the parathyroids probably exert an influence on calcium metabolism in some way. This fact may be of some importance in connection with the increased calcium content found in cortical cataracts. Peters thinks that cataract, following tetany, is due to a shrinking of the nucleus brought about by interference with the normal nutrition. His suggestion is that cramp of the ciliary muscle, which occurs in the course of the fits, causes an irregularity in the supply of lymph.

As might have been expected, from the influence which the thyroid is known to exert upon the nutrition of ectodermic structures allied to the lens epithelium, attempts have been made to connect disorders of this gland with the pathogenesis of cataract, and the disease has been noted to follow *conditions associated with a deficiency of thyroid secretion.* Cataract has been observed to occur after removal of the thyroid, either for experimental purposes or for surgical reasons. Thyroidectomy is not, however, always followed by cataract and, assuming the operations to be complete, some additional factor must be present to cause the disease in such cases. In this connection it must be remembered that it may be difficult to avoid injury to or removal of the parathyroids in the execution of a thyroidectomy. Vossius attempted to show an association between cataract and goitre, but failed to establish the connection ; this, however, is hardly to be wondered at, since the activity of the thyroid, and possibly of the parathyroids, is a variable quantity in goitre.

Cataract has frequently been produced experimentally by the oral administration of *naphthalin*, and a congenital cataract has been induced by giving this poison to the pregnant mother. Naphthalin usually causes a violent catarrhal diarrhœa, and Rossbach has noted the occurrence of headache, mental depression, digestive disturbances, irritation of the bladder, and muscular twitchings in the human subject as a result of poisoning by it. Kolinsky has found hæmorrhages into the choroid and ciliary body

as a result of experimental naphthalin poisoning, and has observed a congestion of the ciliary body and processes in all such cases.

Cataract has on several occasions been observed to follow *poisoning by ergot*, in which cramps and convulsions have been prominent symptoms.

Frenkel has observed a *diminished renal permeability* in patients suffering from cataract, which is unaccompanied by a macroscopic lesion of the kidney, or by any effect upon the general circulation. He states that it must be admitted that a diminution of renal permeability, so slight as to evade recognition through general symptoms, may suffice to retain in the organism substances which are toxic to the lens.

Von Michel has suggested that a connection may exist between atheroma of the carotids and the occurrence of senile cataract; but this suggestion is not supported by clinical experience.

A *hereditary predisposition* to the formation of cataract is fairly generally admitted, and numerous observers have recorded instances in which successive generations have been affected by the disease. Anticipation, or the appearance of the disease at an earlier age in succeeding generations, has occurred in some cases, and the writer recollects one such in which a Hindu woman, aged 20, whose mother had been operated upon for senile cataract a few years previously, developed a presenile cataract in each eye, and brought with her to hospital her three children, the eldest being 6 years old, all of whom were affected by double cataract.

Roemer has suggested that the degeneration of the lens in senile cataract may be due to the development of *auto-cytotoxins* in the organism, as the result of a senile metamorphosis of the tissues. He points out that a large part of our body cells are continually being destroyed under physiological conditions, and that autotoxins would be developed in the absence of some regulative device. "When the man has passed the acme of his powers, and the senile involution of his organs has begun, very minute regulative

devices must intervene to prevent the formation of noxious products of metabolism. If these [devices] fail to a greater or less degree, there may appear products of metabolism such as are able to injure the epithelium of the lens. Regressive changes in metabolism and cataracta senilis are inseparably associated, and thus the senile cataract appears to be a specific metabolic disease of the lens."

It has been suggested that *the nature of the diet* may, in some cases, have an effect upon the development of lens opacities. Since the population of India is divided into sections which present marked differences in dietary, a study of the incidence of cataract in that country should afford valuable evidence as to any influence diet may have upon the causation of the disease. As far as the South of India is concerned all classes of the indigenous population seem to be about equally affected. The disease appears to be more common in the hotter and drier districts of the North of India than in the more humid South. The lack of essential food factors is a feature which is common to all parts of India, and this lack is frequently proved by the appearance of beri-beri and of scorbutic conditions. Such a *deficiency of vitamins* is likely to be most marked in the more arid areas, though it probably exists in all parts of the country during the hot, dry season. It has been shown that the endocrine organs are powerfully affected by a deficiency of certain food factors. M'Carrison's observation that lack of vitamins, when associated with a diet too rich in starch, leads to disordered function of the whole endocrine system of the pigeon, is of interest in this connection.

Diabetes and toxæmias are generally recognised to be associated with a disturbance of the endocrine organs, and the changes in metabolism thus produced may, in some cases, cause a degeneration of the lens fibres in a manner similar to that of senility.

Whatever the main cause of primary progressive cataract may be, the evidence suggests that it is, in the vast majority of cases, a constitutional one, and is a frequent, though not invariable, result of the retrogressive tissue changes found

in senility. When the cause is independent of senility, it may result from many different conditions, such as from diabetes, from bacterial poisons, from some chemical poisons, and from disturbances of the functions of the endocrine glands which are at times associated with fits of tetany, and with other signs of deficiency of secretion. The cause, when present in a sufficient degree, may produce an opacity by bringing about a degeneration either of the lens fibres or of the capsular epithelium. It may directly affect the cells, or it may produce a disturbance of the function of the structures responsible for the nutrition of the lens fibres and capsular cells. Products of metabolism are allowed to accumulate, which are either directly harmful to the fibres and cells, or which may become so in the presence of more local factors, such as light rays of short-wave length.

Failure of the generative glands to function fully is a leading feature of senility, and, owing to the delicate balance that exists between the activities of the internal secretory organs, such failure must require a compensatory effort on the part of the other endocrine glands. The difficulty of bringing about an efficient compensation will be much enhanced by the existence of factors such as secondary infections and food deficiencies. The evidence suggests that a faulty action of the parathyroid glands precedes the development of some forms of progressive cataract.

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CHAPTER IV

VARIETIES OF CATARACT

Anterior polar cataract—Posterior polar cataract—Central cataract—Fusiform cataract—Coralliform cataract—Disc-shaped cataract—Doyne's discoid cataract—Punctate cataract—Lamellar cataract—Anterior and posterior cortical cataracts—Glassblower's cataract—Presenile cataract—Traumatic cataract and its treatment and complications—Clinical varieties of senile cataract—Swelling senile cataract—Shrinking senile cataract—Hypersclerotic cataract—Supranuclear cataract—Arcus senilis of lens.

An attempt to classify the varieties of cataract cannot be wholly satisfactory whilst we remain in ignorance regarding the causation of each type and the relation of one variety to another. Under the circumstances it is preferable to consider the question purely from the clinical aspect and to divide cataracts into two classes—I. Partial and non-progressive, or which show little tendency to progress; II. Progressive, which tend to lead to a total opacity, passing through the stages of *incipient cataract* and *immature cataract* to *mature cataract.*

CLASS I.

Anterior Polar Cataract.
Posterior Polar Cataract.
Central Cataract.
Fusiform Cataract.
Coralliform Cataract.
Disc-shaped Cataract.
Doyne's Discoid Cataract.
Punctate Cataract.
Lamellar Cataract.
Anterior Cortical Cataract.
Posterior Cortical Cataract.

CLASS II.

Presenile Cataract.
Senile Cataract.
Glassblower's Cataract.
Traumatic Cataract (including those varieties due to lightning and electric shock).

Anterior Polar Cataract.—This forms a dense and sharply defined opacity which is usually situated in the centre of the pupillary area. The opacity is due (1) to a circumscribed proliferation of the cells which line the anterior layer of the lens capsule, and (2) to the hyaline changes which they, and the subjacent cortical lens fibres, subsequently undergo. The size of the opacity is seldom large, and is often little bigger than a pinhole. The proliferated cells sometimes form a flat patch beneath the capsule, showing no sign of elevation above the surface; but may, in other instances, form a heaped-up, pyramidal-shaped mass which is named *pyramidal cataract.* The fibres of the lens cortex, beneath the diseased area in the capsule, commonly undergo degeneration, and are converted into hyaline masses—the size of the opacity being thus increased. A layer of capsular cells may grow from the margin of the opacity, and, passing beneath the degenerated tissue, separate it from the healthy cortex. These capsular cells, in course of time, may lay down a new membrane between themselves and the opaque tissue, so that the laminated mass of cataractous matter becomes enclosed in a hyaline capsule; when this change occurs, the original capsule and underlying hyaline matter can sometimes be lifted off, leaving the lens substance covered by the new-formed capsule. As the lens grows, healthy young lens fibres may in some cases be laid down between the degenerated cortex and the diseased capsule, the cortical opacity appears in consequence to sink deeper into the lens substance, and a double opacity may be produced in this manner (Fig. 2). Anterior polar cataract may be congenital or acquired.

The acquired variety of anterior polar cataract is associated with ulceration of the cornea, and may be due to irritation of the capsular epithelium by toxins derived from the ulcer, or to the contact of the lens surface with the cornea after perforation of the latter by the ulcer, or to a combination of these causes. Treacher Collins has laid stress upon the importance of a lowering of the intracapsular tension as a factor in bringing

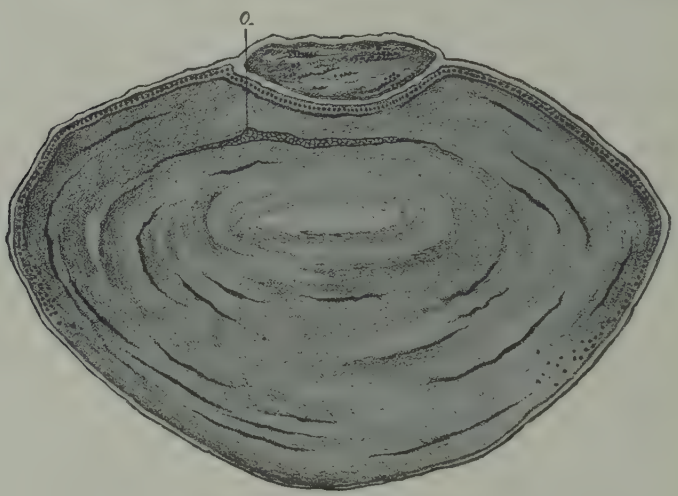

Fig. 2.—Anterior Capsular Cataract. The cataract is one of eleven years' formation. A new capsule has been formed beneath the opacity. A second opacity (*o*) lies in the substance of the lens.

(From Parsons' *Pathology of the Eye.*)

about proliferation of the capsular epithelium, and so causing an anterior polar opacity. Contact between the lens capsule and the cornea interferes with the nutrition of the lens fibres beneath the area of contact, and is followed by degeneration of the latter; the breaking down of these decreases the intracapsular tension in their vicinity, and stimulates the capsular cells to multiply by lowering the pressure upon their surface.

The congenital variety may be due in some cases to an intra-uterine inflammation of the cornea, slight swelling

of which structure will readily cause contact between its deep surface and the lens, owing to the shallow depth of the anterior chamber during fœtal life, and in others (Hess) to some impediment to the separation of the lens vesicle retarding the closure of the anterior layer of the capsule. Congenital anterior polar cataract is often bilateral, and is sometimes associated with other congenital forms of cataract in the same lens. When considering whether an anterior polar cataract is acquired or congenital, it must be remembered that the cornea of an infant often possesses a considerable power of regaining its transparency after injury, and that the site of a former perforating ulcer may be marked by an opacity which is only just visible.

No *treatment* is usually required for this form of cataract, as it is seldom of sufficient size to interfere seriously with vision. An optical iridectomy may be performed if the pupillary aperture is obstructed by the opacity.

Posterior Polar Cataract.—This is an opacity which is found on the vitreous surface of the posterior layer of the capsule, and should be distinguished from opacities which have formed in the posterior portion of the lens cortex. It results from the incomplete disappearance of the vascular tissue connected with the hyaloid artery which carried blood to the posterior part of the vascular sheath of the lens during fœtal life. It is seen as a small, sharply defined, white dot at the back of the lens, and is best observed by transmitted light when it appears as a dark dot in the red reflex, and apparently makes wide excursions in a direction opposite to the movements of the patient's eye. As might be expected from its origin, posterior polar cataract is frequently associated with the presence of persistent portions of the hyaloid artery, and is a congenital condition. No treatment is required. Opacities on the posterior capsule may also result from an abnormal proliferation of the cells of the anterior capsule ; these, in conditions such as retinitis pigmentosa, may form a lining to the posterior layer of the capsule ; such opacities are situated upon the lens surface of the capsule, and are not limited to the pole of the lens, but form a diffuse

opaque area; on examination by transmitted light, the opacity resembles a film of fine, dark bubbles. Opacities of this nature do not, however, constitute a polar cataract, since they are by no means limited to the polar region.

Central Cataract is a congenital condition in which there is a small spherical opacity in the centre of the lens. Hess has described the lens of an embryo fowl, in which the lens vesicle did not separate from the corneal epiblast, its anterior layer remaining unclosed. Lens fibres, derived from the posterior layer, proliferated through the opening and were thrown off. It is suggested that if, in such a case, development had continued, the lens vesicle would have closed, and that a central opacity would have developed owing to fresh lens fibres being laid down around the degenerated area. Hess and other writers have noticed that the nucleus in these cases is often situated abnormally far back in the lens. Central cataract may sometimes exist in combination with other varieties of cataract. It would be difficult or impossible to procure its absorption by discission in such cases. No *treatment* is required as a rule, but vision may sometimes be improved by an optical iridectomy. If it should be decided to remove the lens, it would be necessary to perform a preliminary discission and a subsequent linear extraction.

Fusiform Cataract, which is also called *Axial Cataract* and *Spindle-shaped Cataract*, is an opacity which extends from the anterior to the posterior pole of the lens. The diameter of the opacity is greater at the centre than at either pole. This form of cataract is related to the central, coralliform, and lamellar cataracts (Knies). It has been attributed to the adhesion of the nucleus to the anterior and posterior layers of the capsule, so that the nuclear fibres become drawn out into a spindle as the lens develops and increases in size.

Coralliform Cataract (Fig. 3) is a closely allied form of opacity. In this variety the opacities appear as tubular off-shoots, and radiate outwards and forwards, ending in ampullæ near the capsule, so that the whole mass

of opacity resembles a branch of coral. The condition is probably due to some disturbance of development situated in the lines of the lens sutures.

Disc-shaped Cataract (Fig. 4).—Treacher Collins has anatomically examined this type of cataract and found the lens to be flattened antero-posteriorly. The central portion of the lens was converted into a laminated mass of tissue similar to that met with in anterior polar cataracts, whilst on each side of this lay lens substance showing a variable degree of disturbance, but becoming more normal towards the periphery. The whole lens resembled a dumb-bell, the handle of which was represented by the laminated tissue composing the central part of the lens, whilst the expanded extremities were represented by the less altered tissue in the periphery of the lens. He

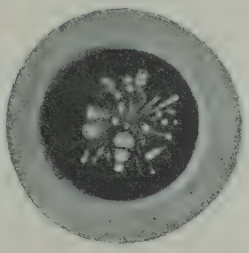

FIG. 3. — Coralliform Cataract. The ampullæ at the extremities of the tubular off-shoots are well shown.

(From Parsons' *Pathology of the Eye.*)

FIG. 4.—Disc-shaped Cataract. A mass of ill-formed lens fibres lies on either side of the dense, opaque, central tissue. (After Treacher Collins.)

(From Parsons' *Pathology of the Eye.*)

attributes the condition to a failure of the nucleus to develop, whilst the cells lining the anterior and lateral portions of the capsule continue to grow and to lay down lens fibres; these fibres are, however, arranged irregularly since there is no nucleus around which they can group themselves. He suggests that the central mass is pro-

duced by the cells of the anterior capsule as the outcome of lowered intracapsular tension in their vicinity, owing to the absence of the nucleus, just as occurs in other forms of anterior capsular cataract. Collins and Mayou describe the appearance of the cataract as a dense white central opacity which, while extending to the anterior surface of the capsule, is at a distinctly deeper level than the surface of the iris at the pupillary margin. Around

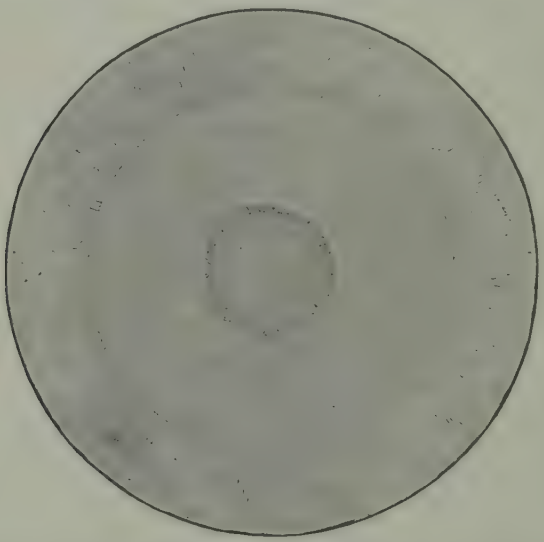

Fig. 5.—Doyne's Discoid Cataract. (After Nettleship and Ogilvie.)
(From Parsons' *Pathology of the Eye.*)

the central white patch there is usually some irregular greyish opacity in which it seems to be set. They also draw attention to the fact that the central opaque portion may be detached during a discission operation, and may remain for an indefinite time in the anterior chamber without being absorbed.

Doyne's Discoid Cataract (Fig. 5).—This is a congenital and hereditary type of opacity which takes the form of a sharply defined disc placed deep in the lens between the nucleus and the posterior pole. The type was first noticed by Doyne in 1888 amongst members of a family named

Coppock, and is hence often alluded to as Coppock cataract. Ogilvy and Nettleship have investigated a number of cases of the disease. They found the cataracts to be absolutely stationary, to be always double, and to be without exception accurately symmetrical in both eyes. A triradiate structure was evident in some cases. The opacity was often of sufficient density to prevent a view of the fundus being obtained if an attempt was made to see through it. Collins and Mayou attribute the triradiate opacity to a disturbance along the line of sutures which are situated close to the poles of the lens ; these later sink into the lens substance as unaffected lens fibres are laid on around them. The opacity is very faint in some cases of the disease, and interference with sight seldom occurs to any great extent.

Punctate Cataract is a condition in which numerous small dots and linear opacities are found in the peripheral portions of the lens cortex. The linear opacities are delicate, and often ellipsoid in form, and lie in a radial direction. The opacities do not tend to invade the peripheral equatorial region, but may lie in great numbers just internal to this area. Both eyes are affected, but the visual disturbance is very slight since the central region of the lens remains free.[1] The opacities are grey or white in colour, but frequently they appear blue when examined by focal illumination and a loupe. Although the opacities in congenital punctate cataract do not increase in size or number, lenses affected by the disease appear to be specially liable to develop cataracts of the senile type. Collins and Mayou consider that the opacities are probably due to failure of the laterally formed lens fibres to develop in the normal way, that the fibres break up into granular substance, and remaining as such, become surrounded by new-formed healthy fibres.

Roemer has found punctate cataract to form nearly half of all the cataracts he met with in old age, and appears to be doubtful as to the congenital origin of the condition, though he admits that it commences at an early period

[1] Tiny specks may be present in the central area of the lens in considerable number, and may yet cause surprisingly little loss of sight.

of life—"not rarely in the twenties"; he emphasises the importance of the use of the loupe in the recognition of the disease, and states that, should it be necessary, these cataracts are easy to remove completely, and are specially suited for the simple operation without iridectomy. Isakowitz attributes the blue colour, observed in these cataracts (*cataracta cœrulea*), to dispersion of light due to vacuoles, filled with a vitreous, or finely granulated substance, lying between the lens fibres. It is likely that a blue or opalescent appearance of the opacities is not confined to congenital punctate cataract.

Lamellar or Zonular Cataract is the most common form of cataract in children. In this disease, a shell of opacity lies in the substance of the central part of the lens in such a way that the opacity encloses clear lens substance, and is itself surrounded by transparent lenticular tissue. The disease is usually bilateral, and equally developed in each eye. The opacity is caused by the presence of very numerous minute foci of degeneration, which lie in the zone between the nucleus and the cortex. Similar fine foci may be found in the nucleus, but in much smaller numbers. On examination of the eye by oblique illumination, the opaque area is seen to be rounded and to lie in the depths of the lens; the opacity appears to be more dense at its periphery than at its centre, and peculiarly shaped prolongations may often be observed at its margin. These prolongations somewhat resemble the spokes of the steering wheel of a ship, but are often V-shaped and so situated that the V is placed astride the margin of the opacity; they are called "riders" for this reason (Fig. 6). When examined with the ophthalmoscope, the opacity appears as a central dark disc against the red reflex which is obtained through the transparent peripheral portion of the lens. Since the nucleus retains its transparency, the centre of the disc appears to be less opaque than the

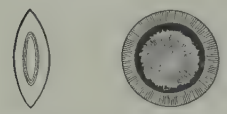

FIG. 6.—Lamellar Cataract. Front view and sectional view. (After Lawson.)

(From Parsons' *Pathology of the Eye*.)

periphery. Lamellar cataract is usually stationary, but may progress in some instances. The disturbance of vision to which it gives rise will vary according to the size and density of the opacity, and in some cases an operation will be required in order to improve the sight. An optical iridectomy will often prove sufficient, and, if the vision is improved by placing a disc with a pear-shaped aperture in front of the dilated pupil, such an operation is likely to be of benefit. The position of the aperture, which most improves the vision, will afford a guide to the most favourable site for the iridectomy. Removal of the lens by discission or by linear extraction may be necessary in some cases ; this has the disadvantage, however, that it not only renders the patient hypermetropic, but also deprives him of the power to accommodate for near objects. Some doubt exists as to the time at which lamellar cataract develops, and whether a child is born with the disease or not ; a considerable number of surgeons hold the view that it is congenital in many cases, but that it often develops during the first year of life ; several cases have been noted in which the zonular opacity had developed in an eye that had been observed to have been healthy at a previous date.[1]

The association of lamellar cataract with rickets, defective development of the enamel of the teeth, and the convulsions of tetany, has been noted by several observers. Children affected by the disease are often mentally backward or deficient. The condition is frequently hereditary.

Anterior Cortical Cataract and Posterior Cortical Cataract.—These are characterised by the formation of an opacity, shaped like a rosette or a star, whose centre corresponds to the pole of the lens. Delicate lines of opacity radiate from the margin of the figure towards the periphery of the lens. The posterior cortex is more commonly affected than the anterior.

Both these forms of cataract are frequently an expression of malnutrition of the lens, and are associated with diseases of the uvea, such as retinitis pigmentosa and choroiditis,

[1] H. B. Grimsdale, *Ophthalmoscope*, vol. iii. p. 388.

so that their removal seldom results in any great improvement of vision ; a slight improvement, sufficient to be of value to the patient, may, however, be sometimes obtained, especially in cases of retinitis pigmentosa. Anterior and posterior cortical cataracts may remain stationary for a very long time, and then progress until the opacity becomes total. Similar opacities may sometimes be observed after the occurrence of an injury to the lens, in which case the opacity may progress or may sometimes disappear altogether.

Glassblower's Cataract.—This is a form of cataract which has been observed amongst bottle makers, furnace workers, and others whose occupation exposes their eyes to intense heat and glare. It is characterised by an opacity in the posterior part of the cortex, near the posterior pole of the lens. The opacity, when viewed by transmitted light, has a margin which resembles a lacework edging. Both eyes are usually affected, and, as might be expected from its situation, the interference with vision is often out of proportion to the size of the opacity. The progress of the disease is slow, and it may remain stationary for several years. Robinson considers that there is usually a period of three years between the commencement of failure of vision and the occurrence of disablement. He states : " The opacity first appears at the posterior pole of the lens, immediately under the posterior capsule, and is often irregularly disc-shaped. By oblique illumination it is distinctly brass-coloured. The outline of the disc-like part is well defined ; but the opacity is less dense and shades off towards the equator. As the haziness spreads, it at first clings closely to the posterior capsule, so that it is saucer-shaped in the earlier stages of the disease, the concavity of the posterior capsule of the lens being easily seen by oblique illumination. By direct examination with a plus 10 D lens, the central disc is sometimes seen to be not completely opaque, the opacity often presenting an irregular network appearance within an irregular circle, and the surrounding less dense opacity is often like a cobweb. From the posterior pole the cloudiness and opacity

gradually spread to the rest of the cortex, and when the cataract is ripe the lens has a pearly hue."

The same writer concludes that the infra-red rays of the spectrum are the cause of the disease. He also states that sight is generally good after the cataract has been removed. He quotes Legge as considering that the left eye is more affected than the right.

It has been suggested that cataracts, of this nature, may be due to the great amount of evaporation from the surface of the cornea and to excessive sweating.

Presenile Cataract.—Primary progressive cataract is not confined to those who are of middle age and over, but sometimes develops during youth, and may even be present before birth. The lens changes in such cases are similar to those which occur in the cataracts of later life, but, in juvenile cataract, the stage of hypermaturity is more frequently accompanied by the formation of a membranous cataract, due to capsular changes. Total cataracts in young children are sometimes associated with other signs of mal-development, such as mental deficiency, and a family history of cataract is not uncommon. The disease, in some cases, develops after an occurrence of fits of tetany, or after a severe constitutional disease, such as cholera. *The urine of a young person, who suffers from presenile cataract, should always be carefully examined for the presence of sugar*, since the occurrence of progressive cataract in youth is sometimes a manifestation of diabetes. Juvenile cataract is most often of the swelling type, and leads to the formation of a Morgagnian cataract in its later stages.

The treatment of presenile cataract consists in the production of aphakia by discission or by linear extraction; the nucleus may, however, in some cases, be of an exceptional size, even when the patient is below the age of 25 years, and it will then be necessary to perform a flap extraction as in the operation for senile cataract. A flap extraction will almost invariably be required if the age of the patient exceeds 30.

Traumatic Cataract.—This results from such an injury to the capsular epithelium as prevents it from exercising

its protective functions over the lens fibres ; the aqueous is thus permitted to penetrate the lens substance and to lead to the degeneration of the lens fibres. The injury, which causes a traumatic cataract, may be either a concussion, unaccompanied by any observable breach in the capsule, or, more commonly, a penetrating injury or a concussion of sufficient violence to cause a distinct breach in the membrane.

A concussion cataract, unaccompanied by a capsular rupture, most commonly causes an opacity in the posterior cortex, which is often of a stellate shape. Opacities, due to this cause, are often stationary, and, in some cases, may even disappear in course of time. A peculiar form of cataract, due to contusion, is that described by Vossius, and named after him, the *cataract of Vossius*. This is characterised by a ring-shaped area of opacity, about 3 mm. in diameter, lying in the centre of the pupillary area ; the opacity is situated in, or just beneath, the anterior capsule, and is made up of a number of dots, which are sometimes of a brown colour, owing to a deposit of iris pigment. The opacities clear up in the course of a few weeks. It is suggested that this form of lens opacity is caused by the pupillary margin having been driven against the surface of the lens.

Cataract caused by lightning and by electric shock may be classed in this group, since Hess has shown that it is due to a destruction of the epithelium of the anterior capsule. The cataract does not always immediately follow the injury, and its appearance may be delayed for some time ; its rate of progress is also variable, and it may remain stationary in some cases.

A blow upon the front of the eyeball, which flattens it from before backwards, will throw a considerable strain upon the zonule and the lens capsule ; rupture of the zonule may follow such a blow if of sufficient violence, and this lesion may be accompanied by a rupture of the capsule. Rupture of the capsule from this cause, therefore, occurs most commonly at the equator, but it may sometimes burst at the posterior pole.

A penetrating wound of the lens is the most common cause of traumatic cataract. The wound may be aseptic, or it may be complicated by the presence of infective matter, in which case the changes, due to inflammation, will be superimposed upon those which are caused by a simple injury to the lens. In the case of an uninfected, penetrating injury, the aqueous gains access to the lens substance through the breach in the capsule, and causes degeneration and loss of transparency of the lens fibres. The fibres, which are brought into contact with the aqueous, swell and show a transverse striation, with the formation of fine granules ; Morgagnian globules and myelin droplets appear, and if any inflammation is present, giant cells may occasionally be found. If the capsular breach remains patent, and if no complications occur, the whole of the cortical part of the lens may become absorbed, and, in the case of a young person, a black pupil may be regained, and good vision may be recovered, if a suitable lens is provided. Should the patient, however, have reached an age at which a hard nucleus has formed in the lens, this result cannot be obtained until the nucleus has been extracted. The breaking down of the lens fibres may be retarded, and may occasionally be arrested by the closure of the capsular rent. When the aperture is a small one, its edges may become united by a fibrinous exudation which covers their surfaces, and a subsequent growth, in the area, of capsular epithelium may effectually seal the opening. The entrance of aqueous may also be prevented by a hernia of swollen lens fibres bulging through the capsular breach. These present a rather striking appearance, resembling a small tuft of cotton-wool or a puff of smoke, as they project into the anterior chamber ; when these swollen cataractous fibres become absorbed, aqueous can again enter the lens substance and degeneration proceed.

An eye, in which a swelling traumatic cataract is present, is in danger of the occurrence of *iritis* and of *glaucoma*.

Iritis, in most cases, is due to the introduction of micro-organisms of low virulence, of which the tissues, being burdened with the task of absorbing lens matter,

are unable to dispose; the source of infection may, however, occasionally be endogenous. Iritis of greater intensity will be met with if the infection has been a virulent one, and all grades of inflammation may be met with, including suppurative changes which lead to a panophthalmitis.

Glaucoma is most often induced, in cases of traumatic cataract, by the swollen lens matter pushing forward the iris and so narrowing the filtration area at the angle of the anterior chamber. Dislocation of the lens, either partial or complete, may also cause glaucoma by bringing about a change in the position of the iris, or by producing a disturbance of the anterior part of the vitreous body.

The treatment of traumatic cataract must be adapted to the nature of the injury and to the state of the eye. In the simplest form of the condition practically no treatment may be required; but it is usually advisable to give rest to the eye by the use of atropine and a bandage. Iritis should be energetically treated by atropine, leeches to the temple, a purge, and the administration of aspirin or salicylates and mercurials; dionine will aid in the absorption of lens matter and of inflammatory products owing to its lymphagogue action. Surgical interference will probably be required if high tension sets in, but it may sometimes be possible, in cases free from iritis, to reduce the ocular tension by the use of leeches, eserine, and a purge; the presence of a leaking wound in the cornea may be of value as a guard against the occurrence of glaucoma in cases where rapid swelling of the lens takes place. A sound sleep for some hours will prove a valuable factor in the reduction of the ocular tension, and a hypodermic injection of morphia may be required to ensure this. It will, however, often be necessary to evacuate the swollen lens matter, and this may be effected by a linear extraction in the case of young subjects; but a flap extraction will be required in the case of those whose lens nucleus has attained any size. In the case of the latter, the risks of the operation will be enhanced by the necessity

of making a section of considerable dimensions, and all means, of the nature described above, should be taken to reduce the tension as much as possible before the operation is undertaken. The performance of a preliminary iridectomy, in the course of which as much soft lens matter as possible is removed by means of irrigation, will often prove safer, in such cases, than the immediate removal of the whole lens.

The difficulty of successfully treating a traumatic cataract will be greatly increased by the presence of a foreign body in the ocular tissues, or by the occurrence of infection, or by a prolapse of a portion of the uvea through the lips of the wound.

If a foreign body has lodged in the lens, or in the anterior chamber, or in the posterior chamber, it can often be extracted whilst removing the lens ; if it lies in the deeper parts of the eye, it may be first drawn into the anterior chamber by a magnet and then extracted, the lens being removed at the same time, if such a measure is indicated. The use of the X-rays will afford an invaluable guide as to the presence of a foreign body in an opaque lens or in the deeper structures.

An *infection* which has caused an iritis must be dealt with on ordinary lines ; but an iritis, which resists such treatment, and is associated with a cyclitis, as shown by a plastic exudation and the presence of keratitis punctata, is an indication for the removal of the eye. An infection, which is sufficiently virulent to cause a suppurative panophthalmitis, will necessitate an evisceration of the globe.

A *prolapse of the uvea* through a penetrating wound may be treated by thoroughly excising the prolapsed tissue and carefully replacing the stump ; if the wound lies at the margin of the cornea, or in the ciliary region, it should be covered by a flap of conjunctiva after the prolapsed tissue has been removed. Such cases should be very carefully watched, as the onset of a plastic inflammation might lead to the loss of the other eye through sympathetic ophthalmitis.

Clinical Varieties of Mature Senile Cataract

Regarded from a clinical and operative point of view, mature senile cataracts may be divided into three main classes: (1) Those in which the cortex is swollen and inclined to liquefy; (2) those in which it shrinks and shows no tendency to liquefy; (3) those in which the changes are nuclear and the cortex is much diminished in amount by sclerosis.

Swelling Cataracts.—The anterior chamber, in the first group, is shallow, and the surface of the lens has a pearly appearance, marked by numerous, fine, radiating sectors. If not fully mature, at the time of operation, it may prove very difficult to detach the lens sectors from the capsule, and these may give trouble by becoming entangled in the wound or by predisposing to iritis. Fine radiating sectors and some "bubbles," situated in the subcapsular cortex, are seen in the early stages of such cataracts. Progress is rapid, and swelling of the lens is a marked feature. Complete liquefaction of the cortex occurs in the late stages, and a Morgagnian cataract results. Small, dense, discrete, white spots appear on the deep surface of the capsule when hypermaturity is reached, and the chamber gains in depth as absorption of the fluid proceeds. Absorption may go on until the chamber becomes abnormally deep, the iris becomes tremulous, and the cataract is represented by a shrunken brown nucleus lying within a spotted capsule.

Shrinking Cataracts.—The anterior chamber in the second group is of the normal depth, and the surface of the lens has a rather dense grey appearance almost free from marking, only a few rays being visible. The cortex can usually be removed by irrigation without much difficulty. Cataracts of this type are slow in developing, and the opacities, in the early stages, are few in number and have a rather massive appearance. When hypermature, the cortex becomes firm and cheesy, and forms a rigid equatorial ring around the nucleus, and the latter,

in patients of middle age, may undergo some shrinking and flattening. The hard cortical masses are easily detached from the nucleus during its delivery, and some care is necessary to remove them from the equatorial recesses of the capsule. Capsular changes are marked in the later stages of hypermaturity, and large patches of opacity form on the deep surface of the anterior layer of the membrane.

Hypersclerotic Cataracts.—The large, dark, nuclear cataract is by far the most common example of the third class. Although this is not technically a true cataract, yet it may be considered to be one for all practical purposes. In its early stages it can be recognised by the dimming of the red reflex and by the brownish colour of the pupil. Lenticular myopia, of low degree, is common during the formation of the cataract. The nucleus increases in size at the expense of the cortex, and the latter may be almost completely absent in the later stages of the disease. Progress is slow and, as the sclerosis of the lens substance advances, staining of the degenerated fibres occurs (probably from oxidisation of tyrosin, p. 16), so that the colour of the large nucleus may vary through different shades of brown to a deep black (cataracta nigra). The red reflex becomes more and more dim with the advance of the disease, and the pupil may, in the most deeply pigmented cases, assume a curious black, metallic appearance. Some vision commonly remains, and the patient may be able to walk without assistance even when the cataract is mature. Any cortex, which has escaped the sclerosing process, may later undergo degeneration, and the dark nucleus may be thus masked by a grey sectored layer of superficial cortical cataract. A lens of this type requires a large incision for its removal; but naturally there is never any great risk of trouble arising from the retention of immature cortex in the chamber. When tearing the capsule, during the extraction of these cataracts, it must be remembered that the instrument (needle or cystitome) is cutting a membrane which lies upon a rather unyielding surface; the zonule in consequence is liable to be ruptured, and the lens nucleus

to be subluxated, if any excessive pressure is made upon the surface of the lens with the instrument. A danger of vitreous escape during the delivery of the nucleus may be easily incurred in this way. The presence of a very black nucleus will give rise to a suspicion of some fundus complication; but disease of the deeper structures is by no means necessarily present in such cases.

A less common cataract of the same group is due to a sclerosis, accompanied by opacity, which is sometimes seen in the eyes of persons under the age of 45, though it may occur later in life. A grey cloud, with very ill-defined edges, appears in the centre of the lens. Under focal illumination the opacity has a soft, faintly green tint. The progress of the disease is slow; but it is unnecessary to postpone operation until the whole of the cortex is involved, as the latter is small in quantity and is easily removed, even though it may be quite transparent.

Cataracts, which belong to the first two groups, originate in the cortex close to the capsule, and most surgeons will agree that their pathogenesis is probably different from that of the last group. It is, however, extremely common to meet with mixed forms, and, in subcapsular cortical cataract, the nucleus is seldom quite clear and free from staining, especially in India. We may also find a cataract in which part of the cortex is shrunken and part liquefying.

Supranuclear Cataract is a rare form which is sometimes met with in old age. It is characterised by a whitish opacity, which appears in the deep layers of the cortex in the neighbourhood of the nucleus. Progress is slow; but the unripe cortical matter is usually easy to remove, and it is unnecessary to await maturity before operating.

Arcus Senilis of the Lens is a type of opacity which is quite common in persons who have reached a considerable age. In this condition a dense ring of opacity can be seen to run round the equatorial margin of the lens. The opacity shows no tendency, however, to encroach upon the pupillary area; its progress is very slow, and there is little or no danger of its ever seriously interfering with vision.

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CHAPTER V

SYMPTOMS OF CATARACT

Muscæ volitantes—Errors of refraction—Diplopia and polyopia—Methods of examination for cataract—Early manifestations—Late manifestations—Shagreen globules in lens—Explanation of the condition to the patient—Diagnosis—Pupil reflex of old age—High myopia—Glaucoma simplex—Intra-ocular tumour—Occlusion of pupil—Lens with double focus.

Diminished Visual Acuity is the most striking symptom of cataract, and the one which, in the majority of cases, first attracts the patient's attention. He usually complains of seeing through a fog. A patient, who suffers from a central nuclear opacity, will generally state that his defect is most noticeable when the illumination is strong, so that he prefers a dull day to a bright one, and likes to keep his back to the light; he also sees better in the morning and in the dusk than in the more intense light of midday. This is due to the fact that, when his pupil is contracted, the clear, peripheral part of the lens, through which vision is possible, is covered by the iris. The symptoms will be reversed if the opacities are situated in the periphery of the lens, and he will then see best when his pupil is contracted. An opacity which is situated in the posterior cortical part of the lens, at or near the nodal point, will produce a disturbance of vision which is quite out of proportion to its size and density.

Muscæ Volitantes.—The careful use of the electric ophthalmoscope will show the presence of fine, streaky, vitreous opacities in the eyes of many middle-aged persons; these may attract the attention of the patient under conditions of eye-strain and temporary derangement of health.

Dark specks in the visual field which appear to float, due to lens opacities, may, however, be distinguished from those due to defects in the vitreous owing to the fact that the former always appear in the same part of the field of vision, and do not alter their position after the eye has ceased to move. The details of muscæ can be studied, and the progress of lenticular opacities can be observed and recorded by the use of an entoptoscope.

Errors of Refraction.—Lenticular astigmatism very commonly develops in connection with cataract, and its correction may lead to a temporary improvement in vision. *Lenticular myopia* often accompanies the formation of those cataracts in which an excessive sclerosis of the lens fibres, unattended by a lessening of the lens curvature, is a marked feature. People of advanced years are sometimes not a little proud when they find that they are able to dispense with their reading glasses; but such evidence of lenticular change should always be regarded with suspicion. *Hypermetropia* occurs rarely, and most often in association with diabetic cataract. It may sometimes be caused by a lessening of the lens curvature; but in the majority of instances is due to the manifestation of a previously latent hypermetropia.

Pain and Ocular Congestion.—These are occasionally present in incipient cataract, and are dependent upon the errors of refraction produced by the disease.

Haloes round Lights are very rarely observed, and are probably due to diffraction and dispersion.

Monocular Diplopia.—This is sometimes found in the early stages of cataract formation, and is due to irregular lenticular astigmatism and to interference with light rays by the opacity in a manner similar to that which occurs when a double pupil is present. A further stage of the same condition is multiple vision or *polyopia monocularis.* Like the symptoms caused by asthenopia these phenomena disappear as the opacity progresses.

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Physical Signs of Cataract

A condensing lens, for focal illumination, a loupe, and an ophthalmoscope are required for the full examination of the lens, and it is necessary to have the pupil dilated. Early changes in the lens are best detected by the ophthalmoscope, the degenerated areas being seen with it as dark objects against the screen of the red reflex. Opacities of the media are most clearly shown by using a convex lens of 12 dioptres in the sight-hole of an electric ophthalmoscope. A concentrated beam of the strongest light is thrown into the dilated pupil, and the white reflex from the optic disc is brought into the field by a suitable movement of the surgeon's head. The observer now moves his head backwards and forwards till he focuses the opaque objects in the media; these appear as dark spots against the white screen of the nerve reflex, and, since they are magnified, their exact shape can be accurately studied. The whole lens can be searched if the observer moves his eye in suitable directions. If an opacity is detected in the media, it must lie either in the cornea, in the anterior chamber, in the lens, or in the vitreous humour. Its situation can be determined by noting the parallactic movements which take place as the observer moves his head from side to side. The apparent movement of an opacity situated in the cornea or anterior chamber, when compared with the pupillary margin, will be opposite to that of the observer's head, whilst an opacity situated in the lens or vitreous will appear to move in the same direction as the observer. The rapidity of the apparent movement of the opacity and the extent of its excursion will be in direct ratio to the distance which separates it from the plane of the iris; an opacity situated at the anterior pole of the lens will therefore appear to be nearly stationary. If the conditions are reversed, and the observer keeps his eye stationary whilst the movements are made by the eye of the patient, then the apparent movements of the opacity will be opposite to those just stated. An opacity situated

near the posterior pole of the lens will appear to make a wide excursion downwards as the patient's eye moves upwards, whilst one situated near the anterior pole will appear almost stationary, or to make a slight movement downwards. *Opacities in the vitreous may be distinguished from those in the lens*, not only by their greater excursion, but also by the fact that though both appear to move with movements of the eye, the movement of the former is independent of such, and continues after the eye has come to rest.

The earliest manifestation of a cataract is sometimes the appearance of a tiny opaque circle in the cortex. This closely resembles a bubble of gas seen at the bottom or on the sides of a tumbler containing soda-water. Such an opacity is often situated in the anterior cortex very close to the capsule. It is interesting to note that these bubble-like opacities are not uncommonly found in association with asthenopia due to errors of refraction, and that they may sometimes disappear after the error has been corrected. The occurrence of definite striæ and sectors of opacity is often preceded by the appearance in the lens of streaks of irregular refraction. These resemble cracks in a pane of glass, or fissures in a sheet of ice. They change their aspect as the ophthalmoscope is rotated, at one time appearing as dark lines, and at another disappearing altogether.

Cortical striæ and small sectors are a common form of early opacity ; these most often occur near the equator, and are said to be most frequently seen in the lower part of the lens. It has been suggested that their occurrence in this situation is due to the influence of light from the sky affecting the lower part of the lens more than the upper. When the opacities increase in size, it becomes easy to detect them by oblique illumination, as they advance into the pupillary area. A condensed beam of light is thrown obliquely into the pupil, and the opacities then appear as grey spots on the black ground of the unaffected lens. The loupe should be used in conjunction with oblique illumination in order to obtain a magnified view.

The anterior chamber appears abnormally shallow when the later stages of a swelling cataract are reached. This is due, of course, to the thrusting forward of the iris by the swollen lens.

An exact record should always be made of the size, shape, and position of any opacities which may be observed in the lens, so that any alteration can be noted at subsequent examinations. Charts of the type shown (Fig. 7) are convenient for this purpose.

As degeneration of the lens tissue proceeds, the opacities extend and coalesce, obscuring the reflex, until, eventually, it disappears altogether. The physical signs in the later stages are very obvious. The grey colour of the pupil is at once apparent in the cortical varieties, whilst even in the dark nuclear types the pupil has a brown appearance which differs sufficiently from the normal to strike the observer at once.

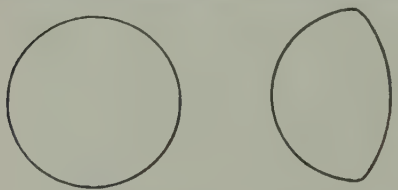

Fig. 7.—Chart for record of lens opacities.

Shagreen globules in the lens have been described by Vogt. These are displayed by powerful focal illumination in combination with a corneal microscope. Vogt has used Gullstrand's Nernst slit lamp for the purpose, and has employed a magnification of from 24 to 48 diameters. Higher magnifications may be obtained, but it is difficult to maintain the steadiness necessary for examination under a very high magnification. The globules vary in appearance with changes in the direction of the light, and they may appear as bright balls or as black circles; their diameter is from $\frac{1}{30}$ mm. to $\frac{1}{15}$ mm. The shagreen globules are not found in the lenses of children; but they are found symmetrically arranged over the anterior surfaces of both lenses in cases of senile cataract. They are stated to be produced by the lens fibres as well as by the capsular epithelium, and are sometimes described as giving an appearance to the surface of the lens like the skin of a shark.

It is inadvisable to lay much stress upon the discovery of early opacities when discussing his case with the patient, especially if he is old. Many people are obsessed with a dread of cataract, and are likely to become much upset, and even melancholic, if told that there are signs of cataract. In order to safeguard his reputation, the surgeon may mention that he has found "flaws" in the lens, and if he uses the word "cataract" he should explain the use of the term, and point out that the surgeon uses it in a generic sense, whereas the patient uses it in a specific one, and associates it with a disease which must inevitably render him blind.

Diagnosis of Cataract

The diagnosis of cataract presents no difficulties if an ophthalmoscope and condensing lens are used in the examination of the patient.

The pupil of old age is always more grey in colour than that of youth; but this reflex is easily distinguished from a senile cataract by the use of an ophthalmoscope.

The lens nucleus may sometimes become highly refractive in *high myopia*, and this gives rise to a grey pupil reflex, which is especially striking when oblique illumination is employed; but this condition can be easily distinguished by the use of the ophthalmoscope.

Non-congestive glaucoma is probably the disease which is most often confused with senile cataract, and every ophthalmic surgeon must have met with many patients, blinded by glaucoma, who have presented themselves to him full of hope that their sight would be restored by an operation for cataract, having postponed their visit until the maturity of the supposed cataract has been proved by the complete loss of sight. The mistake is due, of course, to the fact that progressive failure of vision is a symptom common to both conditions; in glaucoma this is often accompanied by lens changes that cause a greyness of the pupil. If any doubt remains, the use of a tonometer

and perimeter will soon clear up the diagnosis. If the surgeon has not a perimeter readily available, he may make a very rough test of the peripheral field of vision by comparing with it his own in the following manner: The pupil of the surgeon's eye is used as a fixation point for the patient, and the pupil of the patient's eye is used as a fixation point for the surgeon. A travelling object can easily be made by mounting a small piece of card upon a hat-pin. If the right eye of the patient is being examined, his left eye is closed by his hand or by a bandage. The surgeon now places himself 3 feet in front of the patient, closes his right eye, and fixes the gaze of his left eye upon the right pupil of the patient—the latter being instructed to gaze at the left pupil of the surgeon. The travelling object, held in the hand, is moved along the different meridia of a vertical plane lying exactly half-way between the eyes of the patient and surgeon. Any marked difference of the field of vision will be readily recognised in this way.

It is hardly necessary to mention that a glaucoma patient may have very fair central vision and yet be unable to find his way about without guidance; the aspect of the patient, too, is quite different in the late stages of the diseases, as there is a blank stare in glaucoma which is not seen in cataract.

A tumour or exudation involving the vitreous body in the neighbourhood of the lens will cause an alteration in the colour of the pupil which, under such circumstances, acquires a peculiar yellowish appearance accompanied by partial or complete loss of red reflex. If the lens has not become opaque, it can be seen as a transparent substance lying in front of the mass in the vitreous, and this, combined with the colour of the reflex, will show the nature of the disease. Even if the tumour has caused the formation of a cataract, the loss of projection, the alteration in intra-ocular pressure, and, possibly, the presence of congestion, will show at once that the case is not free from complication.

Occlusion of the pupil by membranes may be the result

of inflammation of the anterior part of the uveal tract, or may represent a congenital condition (the persistent pupillary membrane) (Fig. 8). These membranes merely require mention, since their nature is at once shown by their connection with the iris, by synechiæ and iris changes, and often by the presence of a low tension.

A form of *pseudo-cataract*, or lens with a double focus, is occasionally met with, and requires to be diagnosed

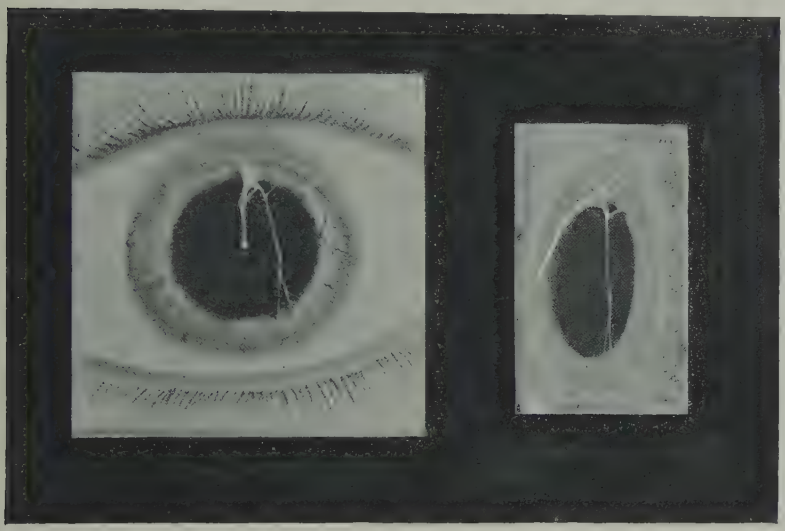

Fig. 8.—Persistent Pupillary Membrane. The attachment to the anterior surface of the iris is seen.

(From Parsons' *Pathology of the Eye.*)

from a true senile cataract. It was recognised by Doyne in 1888, and thus described by him: "On looking at the lens with oblique illumination there appears to be a dense opacity in its centre, so that at first sight it seems incredible that such is not the case. The opacity is, however, only apparent, and is due, I think, to reflection of rays from the sudden increase in the index of refraction towards the centre of the lens. There are frequently a few fine opacities, but that the gross appearance is not real can be seen by direct examination with the ophthalmoscope,

when by moving the direction of the light rays by movement of the ophthalmoscopic mirror, the apparent opacity can be made to move like a shadow, and each part in turn can be made to show its transparency. Again, on looking at the retinal vessels, a distortion, like that seen in conical cornea, is produced by movement of the head as the rays of light pass through the lower or higher refractive parts of the lens." A high myopia of 10 D may be produced by an alteration in the refraction of the central part of such a lens, and considerable disturbance of vision may result. It may prove necessary to remove the lens, if the sight is very bad and is not improved by the use of meiotics and correcting glasses. On two occasions the writer has found perfectly spherical, large nuclei in lenses which appeared to be affected by ordinary subcapsular cortical cataract.

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CHAPTER VI

NON-OPERATIVE TREATMENT OF CATARACT

Spontaneous cure—Medicinal treatment—Use of shaded glasses—Mydriatics—Meiotics—Use of the eyes.

Spontaneous Cure.—A lens, the subject of progressive cataract, may, in very rare instances, undergo absorption, and a spontaneous cure be thus brought about. Such lens absorption is only possible in those lenses that are of the swelling type, and which ultimately become Morgagnian. Some absorption of the nucleus very commonly occurs in such cataracts, and, in rare instances, the nucleus may completely disappear. Such absorption apparently depends upon the presence of enzymes in the fluid cortex, and the iritis, which follows leakage of Morgagnian fluid into the anterior chamber, in cases where there has been no operative interference, proves that irritative substances are present in such cataracts.[1] Elliot has lacerated the capsule of Morgagnian cataracts with every aseptic precaution, and has found that the presence of the Morgagnian fluid in the anterior chamber caused an irido-cyclitis.

Morgagnian fluid itself ordinarily becomes absorbed in time, and, if the shrunken nucleus does not completely obstruct the pupil, vision will then be regained. Such a happy event is likely to be prevented, however, by capsular changes (p. 14), or by dislocation of the nucleus into the anterior chamber causing glaucomatous or inflammatory complications. All the same, a fair number of cases have

[1] In India, where Morgagnian cataracts occur with great frequency, cases of iritis due to this cause are not at all uncommon. It is, however, a little difficult to distinguish those in which the leakage is the result of a trivial injury from those in which it is caused by an attempt to couch the lens.

been recorded, in which both nucleus and cortex have been absorbed, leaving a transparent capsule. Treacher Collins has pointed out that in such cases the epithelial lining of the capsule is absent, and it has been suggested that the epithelial cells may become stripped from their attachment by the free movements of the nucleus, or that they may become detached owing to lack of support from the lens substance. It is possible that the enzymes, which lead to nuclear absorption, are largely responsible for the disappearance of the epithelium which lines the capsule. It is an interesting fact that the fluid cortex of Morgagnian cataracts tends to diminish in quantity after an attack of glaucoma, secondary to the swelling of the lens, has been successfully treated without operation.

For spontaneous cure of a progressive cataract to occur, it is necessary (1) that the cataract should be a Morgagnian one ; (2) that enzymes capable of dissolving the nucleus should be present in the cortical fluid ; (3) that absorption of the cortex should follow and not precede absorption of the nucleus ; and (4) that the capsular epithelium should be either absent or comparatively healthy.

Medicinal Treatment.—Various methods of medicinal treatment have been tried from time to time with the object of promoting the absorption of lenticular opacities and preventing their further spread, and good results have been claimed in some cases. The use of radium, subconjunctival injections, eye-drops and eye-baths, containing various drugs, have each their advocates ; but it is doubtful if any of these can be relied upon to cause the absorption of any existing opacity, though progress may perhaps be stayed in some cases. When estimating the result of medicinal treatment, it must be remembered that lens opacities are most uncertain in their rate of progress, and that they may remain stationary for very long periods ; it is therefore easy for a particular form of treatment to obtain an entirely undeserved credit as having delayed the development of a cataract. It is worth noting that improvement has sometimes been preceded by a conjunctival inflammation.

Radium has been applied with good results by Cohen and Levin. Franklin and Cordes recommend gamma rays, from radium placed at a distance of 1·2 cm. from the eye. The dose is 10 mg. hours twice a week for four weeks, and once weekly after the cataract has ceased to progress. The gamma rays are obtained by passing the emanations through a silver screen 0·5 mm. in thickness.

Potassium iodide has been in considerable use for subconjunctival injection, drops, and eye-baths. Von Pflugk has recommended the subconjunctival injection of $\frac{1}{2}$ c.c. to 1 c.c. of 1 per cent. solution of potassium iodide with a 2 per cent. solution of sodium chloride. Others advise the use of 2·5 per cent. potassium iodide in drops two or three times a day, or eye-baths of the same solution for three minutes, used daily.

Dor has faith in a solution composed of crystallised chloride of calcium, 4 grms.; desiccated iodide of sodium, 4 grms.; distilled water, 500 c.c. The eye is bathed with the solution for twenty minutes every day for three months, then for two months out of three, for the remainder of the patient's life. Roemer has recommended the oral administration of lens albumin in cases of subcapsular cataract.

Colonel Henry Smith has noted good results from the subconjunctival injection of solutions of cyanide of mercury. Dionine has been used fairly extensively to promote the absorption of lens opacities, and is reported to have been beneficial in some cases.

General Principles.—The use of local applications may be valuable in certain cases when both the patient and the surgeon have faith in them; but it should be strictly limited to such cases. It is very important to keep the patient in good heart and to prevent him from moping and worrying over his condition, and each case must be judged on its merits and treated with this object in view. *Sources of auto-intoxication* should be removed, as these not only depress the general health, but are likely to affect injuriously the local disease.

The removal of eye-strain by a careful correction of the

refraction will give increased comfort, and tend to retard the progress of the disease.

When the opacity is central, sight can often be improved by the use of *dark glasses*; these are more efficient if, as recommended by Elliot, the glass is mounted on a tubular shield which projects some distance from the orbital margin (Fig. 9); the natural tendency of the patient to shade his eyes from the light, which comes from above, is imitated in this way. The use of such glasses encourages a moderate dilatation of the pupil, and thus permits better vision to be obtained.

Mydriatics are sometimes prescribed with the same

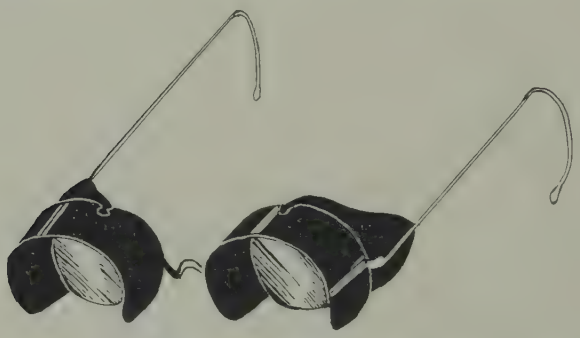

Fig. 9.—Hooded spectacle frames for use in cataract, when the opacity is situated centrally.

object, but their use is scarcely defensible, since they may precipitate an attack of glaucoma; the performance of an *iridectomy*, on the other hand, will ensure a larger pupillary aperture, and thus improve the sight, and at the same time ward off any danger of glaucoma. *Meiotics* are useful when the opacities are peripheral, and when there is a clear area in the centre of the pupil.

If his refraction is suitably corrected, it is inadvisable to debar the patient from reading during the development of a progressive cataract, and use of the eyes may be indulged in as long as no sense of fatigue is felt; common sense will indicate to the patient the point at which he should stop and rest his eyes.

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CHAPTER VII

OPERATIVE TREATMENT OF SENILE CATARACT

Advantages and disadvantages of intracapsular expression—Capsulotomy operation—Simple operation—Combined operation—Preliminary iridectomy—Couching—Results obtained by Indian operators—Vitreous changes after couching—Depression—Reclination.

All operations for senile cataract have for their object the removal of the whole of the lens matter which is opaque, or which is likely to become so, whilst inflicting the minimum of trauma and disturbing the ocular tissues as little as possible.

Those operations, which aim at the removal of the entire lens in its capsule, fulfil the first of these conditions in an ideal manner, but mostly fail with respect to tissue disturbance. The intracapsular expression operation, devised by Colonel Henry Smith of Jullunder, and often known as "the expression operation" or "the Indian operation," is the operation of this type that has been chiefly practised hitherto, and many eminent surgeons have considered that it is the best form of operation to adopt in most cases of senile cataract. This operation gives a very high percentage of most excellent results; but it cannot be denied that it is subject to certain objections, which must place it at some disadvantage (except in selected cases), when compared with one which does not involve the same amount of tissue disturbance. An unduly high rate of vitreous escape is a drawback to the operation. If a long series be taken, it is unlikely that the rate falls below 5 per cent. in skilled hands, and naturally it must be far higher in those that are less skilled. It has been argued that vitreous loss does no great harm to an eye; but if a surgeon will put himself in the place of the patient and ask himself

whether he would object to its occurrence in his own eye, there can be little doubt what his answer would be ! It will be widely admitted that an escape of vitreous must often seriously damage the health of the eye, and that it is a most undesirable complication.

Adhesions of the iris and vitreous to the wound during healing are really serious complications, and they are found with unpleasant frequency after intracapsular expression. The probable explanation is that—(1) The vitreous body is strained by pressure during delivery so that it tends to herniate through the hyaloid ; and (2) once the restraining influence of the lens capsule is removed, any violent or squeezing movement is liable to displace the vitreous slightly forward, so that it comes in contact with the wound or pushes the iris forward into such contact. Once this occurs, cells from the healing surface soon form a connection between the structures. Late infections may use this connection as a bridge by which to invade the eye ; this would explain the late attacks of irritation and inflammation which occur with unusual frequency after the intracapsular operation has been performed. The influence of these adhesions on the causation of the glaucoma, often seen some months after the operation, is too well known to need further discussion here.

Adhesions of the iris and vitreous will often escape observation unless the eye is examined by oblique illumination in a dark room whilst the patient is made to look upwards. They generally occur nearer to the attachment of the iris than to the pupillary margin. A U-shaped pupil is often caused by iris adhesion ; but this should not be confused with the wide, crescent-shaped pupil found after a vitreous escape has occurred. If the vitreous has lain in contact with the wound, a fine, grey membrane will be seen to pass backwards into the eye from the deep surface of the scar.

Minor disadvantages of the intracapsular expression operation are that its successful performance requires the aid of a well-trained assistant, and that it possibly demands more skill in the delivery of the lens than a capsulotomy operation. All the same, if the surgeon makes a sufficiently

large incision, and exerts pressure in the proper direction, he is unlikely to experience any great difficulty in delivery in ordinary cases ; still, excessive pressure may be required occasionally, and untimely rupture of the capsule is not unknown, even in the experience of expert surgeons.

A great argument in favour of intracapsular expression is that a mild degree of infection, sufficient to cause an iritis and secondary cataract in an eye whose tissues are handicapped by the necessity of absorbing lens remnants, may, in these eyes, be disposed of without causing untoward symptoms. The elimination of all chance of after-cataract, if the whole lens is removed in its capsule, and if the eye subsequently heals without complication, is another argument for the operation.

Modifications of the operation, which also aim at the removal of the lens in its capsule, have been devised ; but it is questionable whether many of these greatly lessen the risk of iris prolapse and of adhesions of the hyaloid during the period of healing. Dr. Barraquer's operation of phakoerisis appears to afford the best prospect of avoiding these serious complications, since the vitreous body suffers a minimum disturbance during its performance. The retention of the lens capsule in the eye, however, is not an unmixed evil, for, though it affords a scaffolding upon which inflammatory and other cells may form an after-cataract, yet it also acts as a barrier, which keeps the vitreous body in place whilst the wound is healing, and allows the aqueous to form and separate the vitreous from the wound.

An operation, in which the lens capsule is lacerated, allows the nucleus to be delivered with less disturbance of the tissues, but it has the disadvantages—(1) That some cortex is likely to be left behind, even when irrigation is carefully employed, and that this may prove a source of danger unless perfect asepsis is maintained ; (2) that impaction of portions of capsule may occur despite the greatest care on the part of the surgeon ; (3) that, even in uncomplicated cases, a growth of cells may take place on the surface of the retained capsule and so produce an after-cataract some months after the operation.

Each individual surgeon will prefer the particular type of operation which he has found to yield him good results in the past ; the younger surgeon will, however, probably find that he will meet with fewer complications, if he confines himself to the performance of an extraction of senile cataract with capsulotomy, until he has acquired some considerable experience.

The remark of Sir William Bowman, as quoted by Landolt, is of interest in connection with the selection of a type of operation : " I cannot doubt that the problem of what is to be accounted the best method in any particular class of case will still have to be worked out by our successors, and by theirs, too, but ever remaining open to modifications to suit the thousand personal circumstances of the patient."

Whatever form of operation for senile cataract may be selected, the two main essentials for the attainment of successful results are firstly, and most important, the maintenance of strict asepsis, and secondly, gentleness in manipulation. Eyes vary greatly in their reaction to trauma, and a good result may follow a badly performed operation. So much is this the case that the writer has known a very distinguished surgeon in India declare that " any fool can do a cataract." Few ophthalmic surgeons will, however, agree with this statement, and none will deny the importance of avoiding any unnecessary damage to the ocular tissues. The most scrupulous attention to asepsis must always be the first consideration in this as in other surgical operations.

Iridectomy.—If an iridectomy has not been made previously, it will be necessary to decide whether it should be done at the time of the operation for the removal of the lens (" the combined operation "), or whether it should be omitted and the " simple operation " be performed, and a round pupil maintained.

The great advantage of an iridectomy is, of course, that iris prolapse occurs less frequently after its performance. This is probably due to two causes : (1) Should a sudden rupture of the section occur, there is not the

same risk of the iris being washed into the wound by a gush of aqueous, since this can escape through the coloboma, and (2) the passage of the nucleus through the pupil is liable to stretch the sphincter, and thus to damage the "tone" of the iris, so that it can be swept into the wound by a moderate current of aqueous. This will not be so if a wide aperture is made through which the lens can pass.

An iridectomy has certain disadvantages—(1) It is a minor disfigurement; this is not very important, since the coloboma is partially covered by the upper lid; a patient with senile cataract, too, is usually of an age when minor defects in personal appearance can be accepted with philosophic calm. (2) Glare may be felt excessively. Here, also, the gap in the iris can be covered by the upper lid, and, in any case, glare is not likely to be greatly felt except in the tropics. It may be taken that the patient will make no complaint regarding glare, if the surgeon makes a small and properly shaped iridectomy. (3) A more serious objection is that the ability to cut off divergent rays by contraction of the pupil is largely sacrificed, and this leads to a certain loss of definition. A patient, on whom a simple operation has been performed, may still retain a slight range of focusing power, which, though small, is not quite negligible.

The simple operation is free from these disadvantages, and an eye, on which it has been performed, often seems to heal more quietly than in the case of the combined operation. This is probably due to the fact that it has been less interfered with; also the intact iris acts as a shield, and prevents the impaction of fragments of cortex or of capsule in the wound.

The great disadvantage of the simple operation is that it involves a greater risk of iris prolapse during the period of healing. Unless a careful selection is made, this complication is likely to occur in nearly 10 per cent. of cases submitted to the operation with a round pupil, against about 1 per cent. in combined extraction. This liability to be followed by iris prolapse has caused the simple operation to be condemned by many surgeons.

Greater difficulty is likely to be experienced in securing the complete evacuation of cortical matter in the case of the simple operation than when an iridectomy has been performed.

The tendency to iris prolapse varies greatly in different irides, some being strong with very slight tendency to be washed into the section, whilst others are weak and flaccid. It will usually be found that the former have an excess of stroma which causes the iris to be of a lighter colour. A light brown iris often appears to be more resistant than a dark brown one, and a grey iris to have a better tone than a blue one. A test of tone may be made at the time of the operation by the use of the irrigator, and the simple operation only be performed on such eyes as show a resistance on the part of the iris to be washed into the wound by the irrigator stream.[1]

A peripheral or "button-hole" iridectomy is a compromise between the simple and the combined operation. Here a piece of the iris near its attachment is excised, leaving the pupillary margin and a wide strip of adjacent iris intact. The button-hole opening serves as a channel through which the aqueous can pass to the wound. The iridectomy should be made *after* the delivery of the lens, since, otherwise, the band of iris tissue is apt to be overstrained by the passage of the nucleus, and to lose its tone in consequence. A button-hole iridectomy, performed before the lens has been delivered, has little advantage over the simple operation.

Preliminary Iridectomy.—The performance of an iridectomy some weeks before the extraction of the cataract has certain advantages : (1) It avoids the extra trauma at the time of the operation ; (2) it often temporarily improves the vision of the eye ; (3) it is a safeguard against the occurrence of glaucoma, due to the swelling of the lens ; (4) it sometimes hastens the ripening of the cortex. Its

[1] A patient, who has suffered from an iris prolapse after an operation for cataract in one eye, is specially liable to be affected by a similar complication should the other eye be operated upon, and no unnecessary risk should be run in such a case.

disadvantages are that it commits the surgeon to the combined operation, and that it is often inadvisable to subject the patient to the strain of two operations.

The greatest care should be taken to avoid any infection at the time of a preliminary iridectomy, since such will not only lead to an inflammation and cause a deposit on the lens capsule, but may light up an iritis when the cataract is extracted.

If a preliminary iridectomy is performed, an interval of some weeks should be left before the cataract is extracted, so that the eye can recover completely before the infliction of a further trauma. A preliminary iridectomy is specially indicated if there is evidence of iritis or of any inflammatory condition having existed in the eye at some previous date.

Couching

Couching or depression of the lens is the earliest form of operative treatment recorded. The opaque lens, in this procedure, is dislocated into the vitreous humour, usually in a downward direction, so that it no longer obstructs the pupillary aperture. The operation was known and practised some centuries before the Christian era, and was first described by Celsus, a contemporary of Christ. Couching held the field as the surgical treatment of senile cataract up to the end of the eighteenth century, when the influence of extraction, performed by Daviel in 1745, made itself felt, and at the commencement of the second half of the nineteenth century the operation had almost died out as a surgical procedure. The operation is still much practised in India by itinerant couchers (Fig. 10), and the surgeon, who works in that country, is only too painfully aware of the bad results obtained by them. Elliot, in his book on the *Indian Operation of Couching for Cataract*, has entered very fully into the subject. In an analysis of 780 cases of cataract, operated upon by the Indian coucher of the bazaar, he found that in only 10·59 per cent. was the corrected vision as good as $\frac{6}{18}$ and upward, and that in 78·36 per cent. the corrected vision was below $\frac{6}{60}$.

A western surgeon, who performed the operation under aseptic conditions, would doubtless expect to lose a smaller percentage of eyes than 78·36 ; but glaucoma is very prone to follow the operation,[1] and Elliot has shown the serious character of the changes in the vitreous which follow the displacement into it of the lens. Careful examination with an ophthalmoscope will almost always reveal the presence of exudates in the vitreous, even of those eyes in which the

Fig. 10.—Indian Cataract Coucher at work.

(From Elliot's *Indian Operation of Couching for Cataract.*)

result of couching appears to be most excellent ; the fact that such eyes, although they show a round, black, and active pupil, seldom attain a corrected vision of $\frac{6}{6}$ is further evidence that, quite apart from the occurrence of any appreciable infection, the ocular tissues are damaged by the displacement of the lens. For the reasons stated above, few eye surgeons would deny that couching is now only justifiable in the case of an insane patient.

[1] It occurred in 11·05 per cent. of Elliot's cases.

The lens may be attacked from in front or from behind, and either depression or reclination may be effected. In depression the lens is pushed directly below the level of the pupil, and is placed in such a position that its upper edge

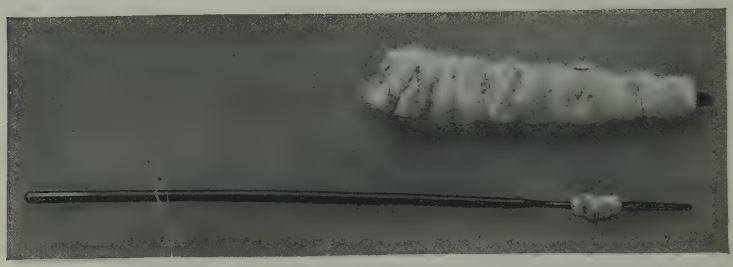

Fig. 11.—Instruments used by Indian Cataract Coucher.
(From Elliot's *Indian Operation of Couching for Cataract.*)

looks forward and its anterior surface looks downward (Fig. 12). In reclination the lens is made to swing backwards into the vitreous on the hinge formed by the lower

Fig. 12.—Depression of lens.

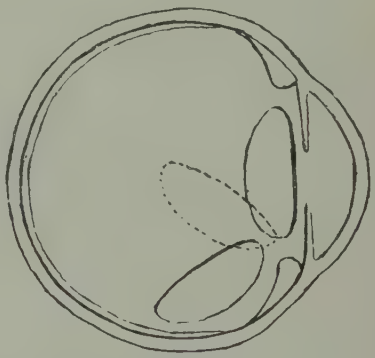

Fig. 13.—Reclination of lens.
(From Elliot's *Indian Operation of Couching for Cataract.*)

fibres of the suspensory ligament, so that its upper edge looks backward and its anterior surface looks upward (Fig. 13). The operation of reclination by the posterior route appears to have been the one most practised by experienced surgeons in the days when couching was still in vogue. Mackenzie divides the operation of

couching into four stages, in only the last of which reclination differs from depression. These are—(1) The pushing of a special needle (Fig. 14) through the coats of the eye at a distance of $\frac{1}{6}$ inch behind the temporal edge of the cornea, and to a depth of $\frac{1}{5}$ inch ; (2) the laceration of the posterior capsule of the lens by vertical movements of the point of the needle, to prepare an aperture for the passage of the lens ; (3) the passing of the needle into the anterior chamber around the edge of the lens, and the laceration of the anterior capsule by vertical strokes ; (4*a*) to depress the lens, the point of the needle is carried over its upper edge, and the handle is raised a little above the horizontal, thereby correspondingly lowering the point, which forces the cataract downward out of sight

Fig. 14.—Needle used in the operation of couching.

behind the pupil—the needle is then withdrawn by rotation ; (4*b*) to effect reclination, the needle-point is raised not more than $\frac{1}{10}$ inch above the transverse diameter of the lens ; its concave surface is pressed against the cataract, which is reclined by moving the handle of the instrument upward and forward, thereby causing its point to pass downward and backward. The cataract is thus made to fall over into the vitreous humour, and is then pressed downward, backward, and a little outward. The technique of the operation is, however, only of academic interest at the present date, since it has been entirely superseded by measures which aim at the production of aphakia.

From observation of eyes, in which a cataract had been couched by an Indian coucher, sight would appear to last longest in those cases where a partial depression of the lens had been effected.

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CHAPTER VIII

PRELIMINARY CONSIDERATIONS AND PREPARATIONS FOR OPERATION

Contra-indications to Operation

Contra-indications to operation—Local sepsis—Oral sepsis—Cough—Diabetes—Leprosy—Mental condition of the patient—Disease of the perceptive elements of the eye and the methods employed to detect it—Monocular cataract—Immaturity—Preparations for operation—Elimination of sources of sepsis—Preparation of the patient for operation—Preliminaries to operation—Anæsthesia—Temporary paralysis of the orbicularis muscle—Preparation of instruments for cataract extraction—Sterilisation of irrigator—Accessories—Eye-drops—Personal preparation of the surgeon—Artificial illumination.

The existence of an active inflammation of the eye, a high intra-ocular tension, an infected conjunctiva, obstruction of the lachrymal passages, dacryocystitis, or the presence of other *septic foci* in the surrounding skin, the ears, nasal sinuses, teeth, and naso-pharynx, contra-indicate operation until the defects have been remedied. The presence of a slight discharge in a conjunctival sac, which has been the subject of a chronic inflammation, need not be regarded with the same degree of suspicion as a similar discharge from a conjunctiva which shows no sign of previous disease, since, in the first case, a short course of treatment will probably prove sufficient to render the sac free from virulent organisms (p. 80). The *patency of the lachrymal passages* should invariably be tested by instilling a drop of coloured fluid, such as fluorescine or argyrol into the conjunctiva, and noting whether it appears in the inferior meatus of the nose. *Oral sepsis* is a con-

dition which it is not always easy to persuade a patient to regard seriously and to have remedied before operation ; but it is a fruitful source of iridocyclitis, and renders the ciliary body of an eye, on which the trauma of an operation for cataract has been inflicted, particularly susceptible.

The general health of the patient is highly important, and, if a temporary derangement is present, the operation should be postponed until matters have improved. A *cough* is likely to lead to a prolapse of the iris by causing a sudden rupture of the wound and a rapid escape of aqueous ; but the danger can be lessened by making a conjunctival flap at the time of operation, and by keeping the patient in a warm room for a few days before the procedure.

Diabetes is no contra-indication to operation on a mature cataract, unless diacetic acid is present in the urine. The presence of diabetes, however, must always be the source of some anxiety to the surgeon, since the resistance to infection is lowered by the disease.

Leprosy need not be considered a contra-indication, provided that the uvea and cornea are healthy.

The mental state of the patient should be sufficiently good to enable him to exercise some self-control after the operation, and to prevent him from interfering with his dressings. It will sometimes be possible to operate upon a patient in his own home, amongst his familiar surroundings, when the strain caused by transfer to a hospital or nursing home would upset his mental balance. The general condition of the patient will sometimes render it difficult to decide whether to operate or not, and each case must be decided upon its merits ; but, since the operation, when properly conducted, causes so little inconvenience or shock, it is, as a general rule, the duty of the surgeon to operate, if the patient has a prospect of six months' life, and has no sight in the other eye, in order that the last few months of life may not be passed in darkness.

The presence of such *disease of the perceptive elements* of the eye as would prevent the acquisition of sight, on the removal of the opaque lens, must be regarded as a permanent contra-indication to operation. Nevertheless removal of

the lens may be of benefit in some of such cases, since the whole of the retina may not be involved, and even a small amount of peripheral vision is of great value to the patient ; he should be warned, however, that he must expect little, if any, sight. Disease of the perceptive elements is usually shown by an inability of the patient to distinguish light from darkness, or to detect the passing of a hand in front of his eye. The presence of *a brisk reaction of the pupil to light* is a valuable indication of the health of the perceptive elements ; the patient's *projection* should also be tested by reflecting the light of a candle into his eye from the plane mirror of an ophthalmoscope, which is held in each part of the visual field in succession. He should be able to tell not only when the light is present, but also from which direction it comes. This constitutes a good test of the health of the retina, but it is not an infallible one since a small lesion in the macular region may escape notice if the peripheral part of the retina is healthy. An attempt may be made to test this area by asking the patient to look directly down a long tube, placed in front of his eye, and then passing the light across the distal end of the tube. Failure to pass the projection test does not invariably mean that an operation is useless, since some patients find a difficulty in understanding what is expected of them, and give misleading answers. When forming an opinion as to the advisability of operating, the surgeon must be guided by all the circumstances of the case, and attach special importance to the appearance of the iris, the briskness of the pupil action, and the presence or absence of any disease, which is likely to be bilateral, in the other eye. It is always important to examine carefully the fundus of the unaffected eye of a patient with cataract—if the state of the media allow it ; also to make a note of the fundus condition in all cases of early cataract. If the patient looks upward, it will often be possible to obtain a satisfactory view of the fundus, even when a considerable degree of opacity is present in the lens.

If a *mature cataract is present in one eye, whilst the other eye is normal*, the advisability of operating on the affected

eye will require consideration. Under such circumstances, binocular vision is exceedingly unlikely to be acquired, even though the operation may be most successful, and the corrected vision of the affected eye excellent. The patient will consequently be disappointed with the result of the operation unless warned that he is unlikely to make much use of the eye as long as the other one remains healthy. There are, however, advantages in operating over and above the æsthetic effect, as the patient acquires a wider field for large objects, and is spared the risks attendant on the stage of hypermaturity. A patient, on whom a successful operation for monocular cataract has been performed, has always a feeling of security, knowing that he has a good eye to fall back upon should he lose the sight of the other by accident or disease. It must always be remembered that an eye which is affected by monocular cataract is specially likely to suffer from some other defect, which may cause the visual result of the operation to be disappointing, and the projection should be very carefully tested, and the prognosis guarded, in these cases.

Maturity.—A cataract is ripe, or mature, when all the cortical fibres of the lens have undergone degeneration and lost their attachment to the capsule which encloses them. This is the most favourable stage for the extraction of the lens, since the zonule is healthy, the capsule is not thickened, and the cortex is easy to remove. The danger attached to leaving cortex in the eye is threefold—(1) Its presence is conducive to iritis ; (2) some of the transparent and sticky cortical matter may lodge in the wound and not only retard healing but lead to later complications (p. 140) ; (3) the rapid swelling of immature cortex, due to imbibition of aqueous, may push the iris into the wound. It is somewhat doubtful whether immature lens cortex *per se* is an irritant capable of causing much more than a slight hyperæmia of the iris. That cortical matter alone is not a powerful irritant is amply proved by the very large number of cases seen in which, during the first few days after a capsulotomy operation on an immature cataract, the pupil has been blocked and the chamber

filled by swelling cortex, and yet the eye has healed without any clinical evidence of iritis, and, remaining quiet and free from congestion, has presented a wide, black pupil after ten days or so. Unfortunately it is quite true that such a favourable course is not invariable, and that iritis does occur oftener in cases operated upon before the lens is mature; but this is undoubtedly caused by an infection which is either endogenous or has occurred at or after the operation. The infection may be of such low dosage and virulence that it would ordinarily be easily disposed of by the iris and aqueous without causing any apparent inflammation; but when these are handicapped by having to deal with lens matter in addition, the bacteria are given an opportunity to gain a footing, to multiply, and to cause inflammation.

The question of maturity will not affect the surgeon who proposes to remove the entire lens in its capsule, since no cortex will be left behind in that case; but should the capsule rupture, and an escape of vitreous occur, during the intracapsular removal of an immature lens, the chance of obtaining good vision is likely to be poor. Most, if not all, surgeons prefer to wait for maturity before undertaking an operation for cataract. The surgeon must, however, adapt himself to the circumstances of his patient, and he should not hesitate, save in exceptional cases, to remove an immature lens, if the patient has a double cataract in otherwise healthy eyes, and is unable to find his way about without guidance. It is not only cruel to allow a patient to remain in a state of blindness longer than is absolutely necessary, but it may have a deleterious effect upon his general health, and so interfere with the success of the operation. A man, who is forced by senile cataract to relinquish his interests and activities for a lengthy period, is likely, at that age, to find it very difficult to resume them after a successful operation; he will thus become senile before his time. In estimating the risks of operation upon an immature cataract, it should be remembered that the amount of cortex present will usually be in inverse proportion to the age of the patient, and that

immaturity is consequently less likely to lead to trouble in an old patient. Maturity should, however, be awaited in those patients who are diabetic, and in those whose cataract is of the rapidly swelling type with narrow, sharply marked sectors. The taking of a slightly increased risk would be thoroughly justified in the case of a patient dependent on his eyesight for a living, and unable to afford a prolonged period of rest; whether this risk should consist in the performance of an intracapsular expression

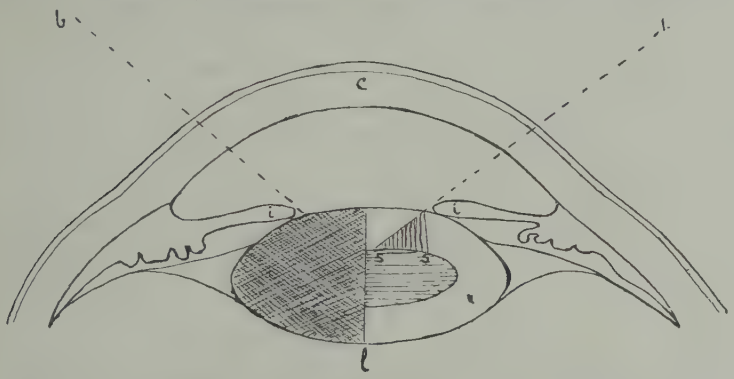

Fig. 15.—Diagram to explain the formation of an "iris shadow." On the left side the lens is opaque right up to its capsule; consequently the iris casts no shadow. On the right side, the centre of the lens is opaque, and its periphery clear; consequently a shadow of the iris is cast by the beam of light, through the clear cortex, on to the opaque nucleus. *c*, cornea; *i*, iris; *l*, lens; *b b*, beams of light; *s s*, iris shadow.

(From Elliot's *Tropical Ophthalmology*.)

operation, or the leaving of immature lens matter in the chambers, must be decided according to the prejudices and general predilections of the surgeon. The performance of an iridectomy, owing to the enlargement of the pupillary aperture, may allow useful vision to be retained for a considerable period in some cases of central cataract.

Tests of Maturity.—*Absence of iris shadow.*—If the lens is cataractous right up to its surface, the iris will lie in direct contact with opaque lens matter, and no shadow can be cast by the iris on to the lens, for the two are practically in the same plane. If, on the other hand, there

is a layer of clear lens matter between the iris and the opaque portion of the lens, an iris shadow is at once seen, cast through the clear layer on to the screen of the deep-lying opaque portion (Fig. 15). The iris shadow is obtained by focusing a light obliquely on to the pupil by means of a condensing lens; a dark crescent will be seen in the pupil on the side from which the light is thrown.

Absence of red reflex.—When a cortical cataract is fully mature, no red reflex will be obtained when the light from an ophthalmoscope is thrown into the eye. In the dark sclerotic type of cataract, unless the cataract is a black one, the reflex will not be lost, but will be dulled.

Reduction of vision to light-perception.—This is the lay test for maturity; but it is somewhat fallacious, since, in the case of rapidly swelling sectored lens, vision may be lost before maturity is reached, whilst it is seldom reduced to light-perception if the cataract is of the dark, sclerotic type.

Preparations for Operation

The details of the preparations made for operation on cataract will necessarily vary, within the limits imposed by a regard for the principles of asepsis, in different clinics, and in the practice of individual surgeons. The measures, recommended in this chapter, must be regarded as a record of those which, in the writer's experience, have proved valuable in all cases of operation in which the globe is opened.

Elimination of Sources of Autogenous Infection.—It is highly important that the patient should be in the best possible state of health, both mental and physical, before an operation for senile cataract is performed, and every measure to ensure this should be taken. Possible sources of autogenous infection, which might prove a cause of inflammation during the healing of the wound, must be carefully searched for. Many sufferers from senile cataract are the victims of oral sepsis and gastro-intestinal troubles—the latter being often dependent on the

former. It is therefore necessary to make sure that the patient is free from *pyorrhœa alveolaris*, and that any remaining teeth are in a healthy condition. Nasal, aural, and pharyngeal disorders should be remedied, and all digestive disturbances put right as far as possible. His home surroundings, whilst waiting transfer to the nursing home or hospital, should be as bright and cheerful as possible, and his friends may be given a hint to curtail the stay of any lugubrious visitors. Once the operation has been decided upon, and its inconveniences explained, it is well to make as light of it as possible, and to lay stress upon its painlessness and its benefits.

Local Sources of Infection.—It is hardly necessary to state that all local sources of septic infection must be eliminated before operation, which should not be undertaken in the presence of any sores or pimples in the neighbourhood of the eye. If the lachrymal passages are found to be impervious, it will usually be sufficient (provided no retention in the sac is present) to dilate the lower canaliculus, and to inject a syringeful of sterilised normal saline solution down the nasal duct. If, on pressure over the site of the lachrymal sac, mucus or muco-pus is found to regurgitate into the conjunctival sac, it is best to excise the former at once. It is advisable to wait for six weeks after this operation before proceeding to remove the cataract, unless circumstances compel the surgeon to incur the risk of a more immediate operation.

The conjunctival sac should be brought into a healthy condition, and should be free from discharge before the cataract operation is undertaken. In many clinics it is customary to take cultures from the sac, and to delay operation until these prove negative. The pneumococcus is usually considered to be the most dangerous inhabitant of the conjunctival sac; but streptococci and staphylococci are also of extreme importance. Elschnig and Harrison Butler have maintained that the staphylococcal group is as dangerous as the streptococcal, and that even the staphylococcus albus may be a source of

grave trouble. A precautionary cultural examination is most certainly an excellent and scientific procedure, and should be adopted whenever possible; but it is somewhat doubtful whether it is really essential, or even advisable, in a large institution where it may be necessary to operate upon thirty or forty cases in a morning.[1]

The use of a trial dressing is a good method of detecting any latent inflammatory condition of the conjunctiva. The eye is occluded by a dressing and bandage for some hours (for a night, if convenient), and if any mucous discharge is present, this will be seen on the lint when the dressing is removed. A serious disadvantage of this method is that the growth of bacteria in the conjunctival sac is encouraged by such occlusion; this may be minimised, however, if a sufficient interval be left between the removal of the bandage and the operation, so that the conjunctiva may have time to recover its tone. If any discharge from the conjunctiva is found, active treatment should be instituted. Nitrate of silver in a 2 per cent. solution will be found to be very valuable. Cocaine is first instilled, and the everted lids are thoroughly painted with the solution, which is then washed out of the sac with saline solution. Special care should be taken to apply the drug efficiently to the transitional conjunctiva. This treatment may be carried out daily, or thrice a week, according to circumstances. Sulphate of zinc in 1 per cent. solution and 1 per cent. optochin (ethylhydrocuprein) may also be used as eye-drops. After two weeks' treatment on these lines it will usually be safe to operate, provided the lachrymal passages are healthy.

The Herbert-Bamber method of conjunctival disinfection is unsurpassed for Indian work. This is carried out about half an hour before the operation is performed. The lids are everted, and the conjunctival fornices exposed as much as possible; a stream of perchloride of mercury

[1] In the Madras Hospital the custom is to rely upon inspection only, and the suppuration rate cannot be considered high (p. 134) if the difficulty of controlling the patients, and the unhealthy nature of the conjunctiva, in many cases, is taken into account.

lotion (1 in 3000) is then directed on to the conjunctiva from a height of about 18 inches, so as to strike the surface of the membrane with some force. The duration of the irrigation lasts from one and a half to two minutes, and is varied so as to suit the type of conjunctiva. The object is two-fold—(1) to wash away mechanically such organisms as may be lying on the surface of the membrane, and (2) to cause such changes in the superficial epithelial cells as will result in the formation of mucus, and in the exfoliation of many of them. The presence of a mass of mucus in the fornices is the test as to whether the irrigation has been sufficient and efficient. Micro-organisms, lodged amongst the surface cells of the conjunctiva, are caught in the mass of mucous and catarrhal epithelium as fish are caught in a net, and the mucus and micro-organisms together may be cleared out of the fornices by a moist mop of cotton-wool, mounted on a probe or stick in the manner described later. It must be emphasised that the object of the proceeding is to remove the bacteria mechanically, and not to kill them by the chemical action of the disinfectant. Two minutes of irrigation is the period required to produce the necessary reaction in the conjunctiva of the average Indian rustic ; but this must be extended to two and a half minutes if there is an excess of fibrous tissue in the deeper layers of the membrane, and may be curtailed to one and a half minutes in those patients whose conjunctiva is more delicate and shows no sign of previous disease.

It is best to admit the patient to the hospital or nursing home at least a day before that on which it is decided to perform the operation, in order that he may become somewhat accustomed to his surroundings, and that he may be properly prepared for operation. The atmosphere of a hospital, in which many operations for cataract are performed, is highly beneficial to his mental condition, since he will be considerably encouraged and cheered by the presence of other sufferers who have been successfully operated upon.

On the evening before the operation his face should

be thoroughly scrubbed with an ethereal soap solution, and at the same time a laxative, sufficient to ensure a proper movement of the bowels in the early morning, should be given. If this fails to act, an enema should be administered on the morning of the operation. If no discharge from the eye or dried secretion on the lid margins is present next morning, the temporal lashes of the upper lid are closely cut with scissors, the blades of which have been smeared with sterilised vaseline ; the object of the vaseline is to catch the hairs and so prevent them entering the conjunctival sac. If it is proposed to divide the capsule before making the section, a drop of 1 per cent. atropine solution is instilled into the conjunctival sac about an hour before the patient is placed on the table, the usual precautions being taken to prevent the drug passing down the nasal duct. Twenty minutes before the operation a hypodermic injection of 0·25 c.c. of trivalin hyoscine may be given ; this will quiet the patient and render him less nervous during the operation. The drug is a product of the Saccharin Corporation, and can be obtained in ampoules of 0·25 c.c. and 0·5 c.c. If trivalin hyoscine is not available, an injection of morphia, combined with atropine, may be substituted, unless contra-indications are present. The standard dose of this is $\frac{1}{4}$ grain of the morphia salt and $\frac{1}{150}$ grain of atropine sulphate ; the dose of morphia may be increased in the case of a healthy, but very nervous patient. If a fresh solution is used, morphia, when combined with atropine, seldom gives rise to any vomiting.

The eye is anæsthetised by four instillations of a 4 per cent. sterilised solution of cocaine and by one instillation of adrenalin chloride, made at two-minute intervals. After the second instillation of cocaine, a subconjunctival injection of cocaine and adrenalin solution is given. The solution is prepared by dropping into a sterilised watch-glass 2 drops of the 4 per cent. cocaine solution, 2 drops of 1 in 1000 liq. adr. chl. (P. D. & Co.), and 4 drops of normal saline solution ; 5 minims of this solution is then injected under the lower part of the bulbar conjunctiva, care being

taken to make the injection as superficial as possible, and to avoid injuring the scleral and episcleral tissue with the point of the needle.

Elliot's bandage is now fixed in position with its free ends rolled back and pinned in position, ready for application on completion of the operation. This bandage (Fig. 16) was introduced in the Madras Hospital by Colonel Elliot in 1897, and will be found to be most satisfactory.

FIG. 16.—Double bandage for the eyes as used in Madras. On the left the bandage is shown ready to be fixed ; one tail has been drawn through the aperture for the ear and pinned in place in the case of the patient in the centre ; both tails have been fixed in position in the case of the patient on the right.

(From Elliot's *Tropical Ophthalmology*.)

It is prepared in the following way : " A piece of bandage cloth is taken 4 inches broad, and of such a length that it will pass one and a half times round the patient's head. The mid-point of the strip is placed over the patient's external occipital protuberance, and the two free ends are held in front of the face by an assistant ; the position of the two ears, and the size of their bases are carefully measured on the bandage. This is now removed, and two holes are cut, one on each side, to fit the bases of the ears. The object of so doing is to fix the bandage so that it cannot slide up or down. Each free end of the

bandage is now slit into three tails from before backward to a point opposite the patient's temples ; each centre tail is 2½ inches broad, while the breadth of each of the four remaining tails is three-quarters of an inch. To apply the bandage, the ears are fitted through the holes made for them, and the two upper and two lower tails respectively are tied together, the one pair over the vertex and the other below the chin. The tails of the middle pair are rolled up and fastened by a pin as already described." [1]

The patient is now brought on to the operating table, a small, hard, round bolster is placed under his head and arranged so that its edge is on a level with his face on the affected side. This allows an irrigator tray to be placed in position, and the assistant to use his hands without being interfered with by the pillow. The height at which the head is placed should be so adjusted as to allow the surgeon to work easily without straining or stooping ; a fair guide is that, if the pillow is placed close to the edge of the table, the latter should be at the level of the surgeon's pubis. An ordinary bed can be used as an operating table if its end is raised by placing blocks of suitable size under its feet. (If wooden blocks are not readily available, books will serve the same purpose.) Even if the bed has a rail at its head, which is too high to allow of its use in this way, it can generally be adapted by changing the position so that the head of the patient is placed at its foot.

A swab of sterilised cotton-wool is next dipped into some tincture of iodine, and with it the face, forehead, nose, and eyelids of the patient are thoroughly painted—special attention being paid to the eyebrow. A sterilised towel is wrapped round the head and pinned in place, in such a way that its edge passes just above the eyebrows, and that all stray hairs are prevented by it from intruding on the field of operation. The edges of the lids are then gently squeezed between the finger and thumb so as to express any Meibomian secretion, and their everted edges are wiped dry with a small mop of wool twisted on to a probe or stick ; when dry, they are immediately painted with

[1] *Tropical Ophthalmology*, p. 260.

iodine tincture, used on a similar mop, the application of which is followed up by an assistant with a fresh, dry mop so as to remove any excess of iodine.

If Herbert's perchloride irrigation or perchloride of mercury ointment have been used, the fornices are next cleared of mucus by swabbing them out with mops, moistened by saline solution ; these are used with a light sweeping movement which raises the lids from the globe, and the stick is gently twisted between the fingers as the mop explores the recesses of the fornices.

A speculum is now introduced directly into the conjunctival sac, care being taken not to contaminate its blades by contact with the lid margins, and the whole sac thoroughly irrigated with sterile saline solution from an undine (Fig. 38) which is held at a height of 12 inches from the eye. During the irrigation the speculum is held well forward, and the upper part of the orbicularis is fixed over the superciliary ridge so as to evert the fornices as much as possible. The eye is now ready for operation.

Anæsthesia.—Cocaine and adrenalin, administered as described above, are quite sufficient to render the operation absolutely painless ; but, if the patient is likely to be entirely beyond control, it may prove necessary to administer a general anæsthetic—the occasions on which this necessity arises are, however, exceedingly rare in the case of operations upon adults. The great objection to a general anæsthetic is, of course, that it may be followed by vomiting with consequent risk of iris or vitreous prolapse. The risk of prolapse can be lessened in some degree by the use of a conjunctival flap, and it is best always to fashion one in such cases.

Van Lint's method of temporarily paralysing the orbicularis, by the injection of novocaine and adrenalin, may often be useful in cases in which loss of self-control and excessive squeezing of the eye are anticipated. A syringe of 2 c.c. capacity with a needle 3·5 cms. long is used, and about 3 or 4 c.c. of the solution is injected.

The injection is made at a point where a line, drawn along the lower margin of the inferior border of the orbit,

intersects a line, drawn along the external margin of the outer border of the orbit.

A horizontal fold of skin and tissue is raised, and the needle is passed deeply through it right along the malar bone. The fluid is injected as the needle is being slowly withdrawn. A second injection is made in the same manner into a vertical fold of the tissues at the outer border of the orbit.

Paralysis comes on in about twenty minutes; but its onset may be hastened by massage. The paralysis lasts for at least an hour.

Instruments required for Cataract Extraction

The instruments required for a cataract extraction are:

1. **The Speculum.**—Clark's pattern (Fig. 17) is that which is most commonly used and, *if the stop is removed,*

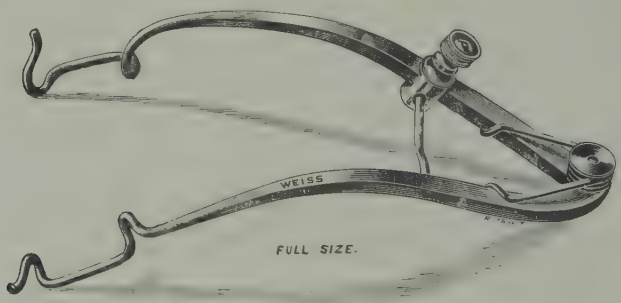

Fig. 17.—Clark's Eye Speculum, with Screw-stop.

is suitable for nearly every case. The stop is a danger since, when in action, it causes the tarsal plates to become rigidly fixed. In such a case, should the patient squeeze, the fixation of the tarsus allows the band formed by the levator palpebræ to be pressed on to the posterior segment of the eyeball by the action of the orbicularis upon the insertion of the muscle. Danger of vitreous loss is thus

produced (p. 106). Smith's speculum (Fig. 18) fulfils most of the requirements of a good instrument.

2. **Lid Retractors.**—Desmarres' (Fig. 19) is the best known retractor. This instrument exposes the eye well, and has the advantage that it covers the lid margin and so lessens the risk of contamination of instruments on their way into the globe. It has the minor disadvantage that

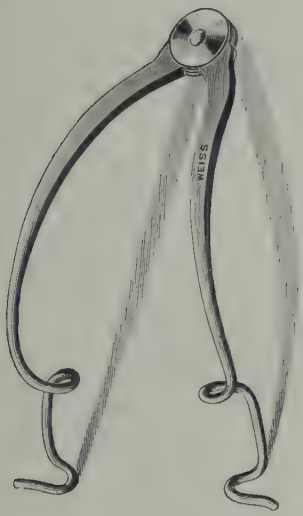

Fig. 18.—Smith's Eye Speculum.

Fig. 19.—Desmarres' Retractor.

Fig. 20.—Smith's Lid Hook.

it occupies a rather excessive amount of room in the conjunctival sac; but it also suffers from a more serious one in that the lid is liable to slip off it, if the instrument is used to pull the tissues forward in the event of a threatened vitreous escape. Smith's lid hook (Fig. 20) is an excellent instrument for the purpose for which it was devised; but it does not, in every case, expose the critical area to the required extent. A double lid hook, as used in the Madras Hospital, has the advantages of a Smith's hook, and allows

a better exposure to be made. Fisher's retractor (Fig. 21) is another instrument of a good type.

3. **Conjunctival Fixation Forceps.**—The blades of these should be of sufficient strength to ensure that they do not yield under pressure, when a firm grip is taken of the conjunctiva, and the spring should be so graduated as to avoid tiring the fingers of the surgeon. The forceps should be furnished with two teeth on one blade, and with three teeth on the other (Fig. 22). A forceps with a spring catch is a dangerous instrument to use in an operation for senile cataract, since it may be difficult to release the eye immediately it is desired to do so, and a vitreous loss may occur in consequence.

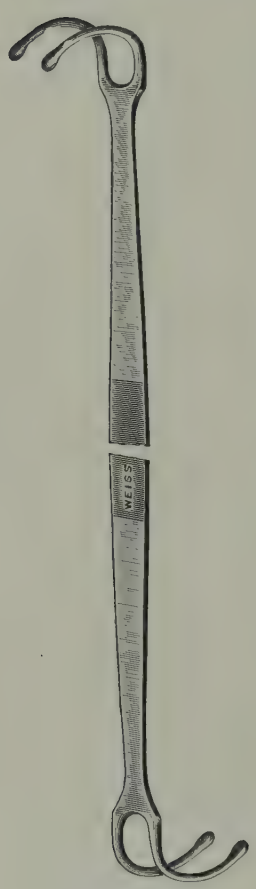

Fig. 21.—Fisher's Lid Retractor.

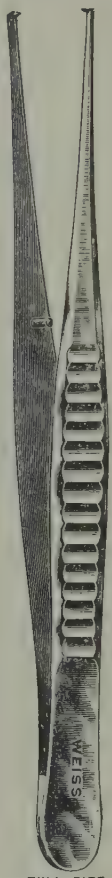

Fig. 22.—Conjunctival Fixation Forceps.

4. **Bowman's Needle.**—This is required if a preliminary capsulotomy is performed, and is a lance-headed needle with a double, sharp, cutting edge. It is important that the shaft, at a distance of 9 mm. from the point, should be of sufficient size to fill completely the aperture made by the cutting head on its entry into the eye, since, if the

aperture be too large, a premature escape of aqueous may occur (Fig. 23). A needle which has been once re-sharpened is the best for the purpose. The needle should be carefully tested on a trial drum before use.

5. **Knife.**—A Graefe's knife (Fig. 24) is the one which is generally used to make the section. A knife which has a narrow blade will usually be found the easiest to use, since its rotation out of the plane of the section does not cause the same degree of displacement as a knife whose blade is

FIG. 23.—Bowman's Needle.

FIG. 24.—Graefe's Cataract Knife.

FIG. 25.—Smith-Wilson Knife.

broader. A Smith-Wilson knife (Fig. 25) will be found to enter and, possibly, to cut through the tissues with greater ease than a Graefe ; but, on account of the slope on its cutting edge, it is sometimes a little difficult to fashion a perfectly regular section with it. The point of the knife used must be carefully tested before operation.

6. **Iris Forceps** should be delicately made with tenaculum points, and have their extremities smooth and rounded. The amount of curvature of their blades which is desirable will depend upon the manner in which the

surgeon performs the iridectomy. A marked curve (Fig. 26) is convenient if the operator introduces the blades well into the chamber of an eye which is turned downward, whereas only a slight curvature is desirable if the technique is to operate with the eye in its natural position of looking straight forward, and to cause the iris to present between the blades of the forceps by making pressure on the corneal lip of the section. The writer prefers the forceps made with a slight curve (Fig. 27).

Fig. 26.—Curved Iris Forceps.

Fig. 27.—Iris Forceps with Open Angle.

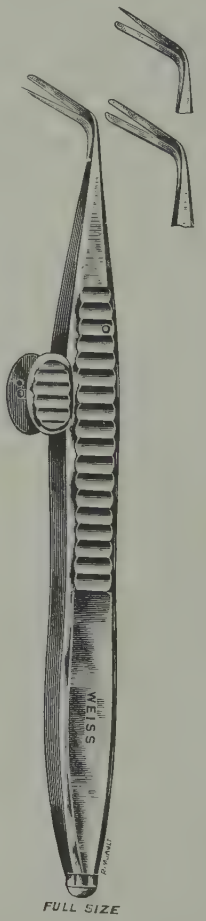

Fig. 28.—de Wecker's Iris Scissors.

7. **Iris Scissors.**—Many surgeons use scissors of the type of de Wecker's scissors (Fig. 28). This is a convenient

instrument, but has the disadvantage that it is a delicate one, and may be out of order when required ; it is also an expensive instrument to buy and to get sharpened. A surgeon who performs many operations, and who is not within easy reach of instrument-makers, would be wise to accustom himself to the use of an ordinary straight scissors, as he easily can do.

Fig. 29.—Graefe's Cystitome.

8. **Cystitome or Capsule Forceps.**— These will be required for an extraction with capsulotomy, if the capsule has not been previously lacerated with a Bowman's needle or with the point of the knife. Graefe's pattern of cystitome (Fig. 29) will be found to be a suitable instrument for capsulotomy. It is important to see that its point is sharp, and that no rust has collected in the angle formed by the junction of point and shaft.

Fig. 30.—Treacher Collins' Capsule Forceps.

Treacher Collins' capsule forceps is well designed to remove a wide area of the anterior layer of the capsule, if it is intended to use forceps for this purpose (Fig. 30).

9. **The Curette,** which is used to deliver the lens nucleus, should have a well-rounded extremity and a blunt edge. Daviel's will be found a useful instrument. Other good forms of curette are Pagenstecher's and the Moorfields pattern. Many Indian surgeons use the elbow of a strabismus hook to deliver the lens, or the bulbous end of a similar instrument which is stouter and rounder than the usual pattern.

10. **Iris Repositor.** — Bowman's platinum spatula (Fig. 31) will be found effective. The blade of the spatula is just as efficient if it is made of silver instead of platinum,

and the former is the more convenient material for Indian surgeons, since instruments of this metal can be easily repaired, or made, by a bazaar silversmith. The instrument usually has a blade at each end of the shaft, and it will add considerably to its efficiency if the tip of one of them is bent so that it forms a right angle with the shaft; this can be easily done by grasping the tip in a dissecting forceps and bending it over. It will be far easier to clear the section with a spatula bent in this way, should the patient's eye be turned upwards during the toilet of the wound, and it will be unnecessary to ask him to look down. It must be remembered that an instrument, which is furnished with a blade at each end of the shaft, requires to be used with great care, since it is very easy for the end not in use to become contaminated, and, if this is introduced into the eye later, infection may occur. It is wiser for the surgeon, unless he has considerable experience, to use such instruments as are effective at only one extremity.

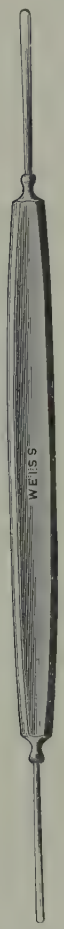

Fig. 31.—Bowman's Iris Spatula.

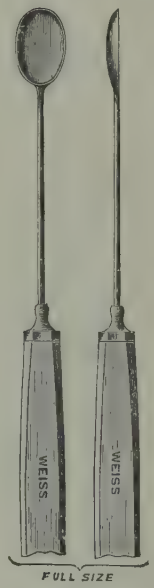

Fig. 32.—Pagenstecher's Spoon.

11. Vectis or Spoon.—One of these instruments should always be made ready for use, though it will only rarely be required. The writer prefers to use a Pagenstecher's spoon (Fig. 32), with the shaft bent as

described on p. 119, if an instrumental delivery is necessary. Taylor's loop vectis is better suited for the delivery of a large, dark lens than for the subcapsular cortical cataract.

12. **The Irrigator.**—M'Keown's irrigator (Fig. 33), in which a rubber bellows is used to evacuate the fluid, or some other variety, which depends upon gravity for the same purpose, is an invaluable aid in the performance of a cataract operation. A formidable array of nozzles is usually supplied with a M'Keown's irrigator, but the best,

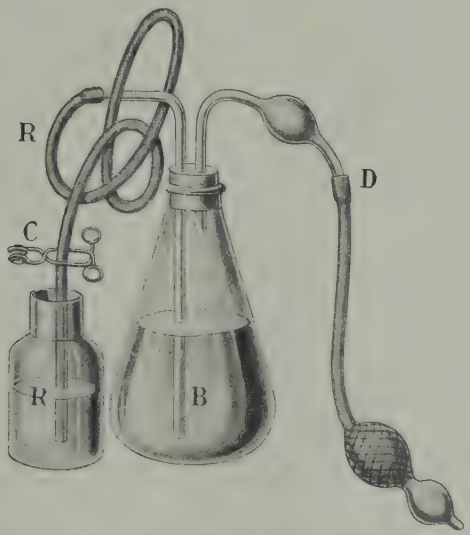

Fig. 33.—M'Keown's Irrigator.

probably, is a simple silver tube, which tapers towards each extremity. The ocular end is flattened from before backwards and bent slightly forward ; its tip is convex, and in it lies a slit-like aperture 2 mm. wide. The opposite end tapers from the widest part of the nozzle for a distance equal to one-third the length of the tube ; it ends in a round aperture from which a long, thin tongue of metal protrudes ; the tongue runs inside the tube, for the greater part of its length, and divides it into an anterior and posterior compartment. The object of the taper at the irrigator end of the nozzle is to allow the indiarubber

tubing to fit it very tightly, so that a leak of fluid is not likely to occur at that place.

Sterilisation of M'Keown's Irrigator.—Detach the rubber bellows from the tube D, raise the glass tube B, as shown in Fig. 34, and arrange the previously sterilised rubber tubing R attached to it, so that the end hangs free and is not in contact with any surface ; the bottle should have

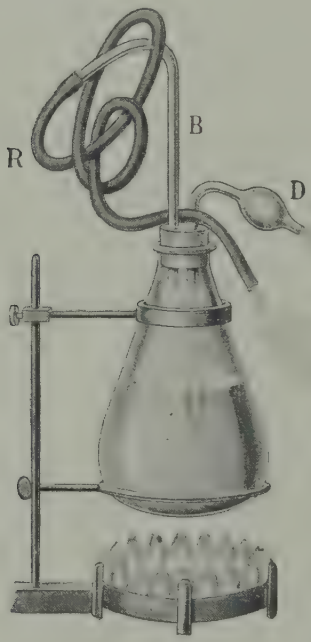

Fig. 34 —Sterilisation of Irrigator.

been filled two-thirds full with sterile normal saline solution, and is now ready for boiling. After free ebullition, and immediately after removal of the flask from the flame, clamp the rubber tube R, and dip its free end into a sterile bottle in which it is kept till the apparatus is to be used ; lower the tube B to its usual place (Fig. 33) ; cool air now enters, but it can only do so through the tube D, the bulb of which is filled with asbestos wool. After sterilisation is completed, the bellows are attached at D (Fig. 33).

When about to be used, the nozzle is taken from the instrument tray and attached to the tube R, and the clamp C is relaxed. It is absolutely necessary to have the fluid carefully filtered and sterilised before it is boiled.

A simple substitute for a M'Keown's irrigator can be made by securely fastening one end of a piece of fine indiarubber tubing, 3 feet long, to the nozzle of an ordinary 2-ounce urethral syringe, and attaching the irrigator nozzle to the other end (Fig. 35). The whole apparatus is boiled for five minutes before use, and is then emptied and filled with sterile normal saline solution (0·8 per cent.). An irrigator of this type is less suitable than M'Keown's for institutional work, where many cases are operated upon in one morning.

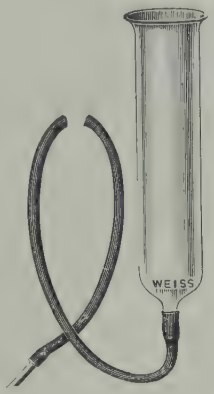

Fig. 35.—Hydrostatic Irrigator.

Fig. 36.—Eye Swab. (From Elliot's *Care of Eye-cases.*)

Accessories.—For the purpose of sponging out eye-wounds, it is of great advantage to use *mounted swabs.* The midribs of the leaves of the palmyra, or of other palms, furnish excellent handles for eye-swabs. These small sticks are used extensively throughout the East for making sweepers' brooms, and can now be obtained from Messrs. Weiss & Co. To prepare a swab properly requires a little care. A piece of wool of the required size is taken, and its edge, on one side, is pulled out as thin as possible ; the handle is then laid upon the extreme edge of the pulled-out portion and rotated so as to twist the wool on to its shaft. A supply of eye-swabs should be placed in a drum with the dressings

and bandages, and be sterilised by steam-heat along with them. The contents of the drum should not be disturbed until required for use, when any article which is wanted is carefully removed with a sterilised forceps.

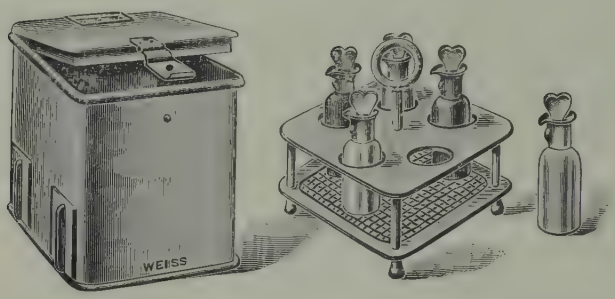

Fig. 37.—Elliot's Cruet for Eye Drop-bottles.

Eye-drops.—It is preferable to keep these in all-glass drop-bottles, each drug in a bottle of a special colour. Elliot's cruet (Fig. 37) is an excellent device in which the drop-bottles may be sterilised and kept for use. This is furnished with "a gauze floor, on which the bottles stand during boiling, so that they are not upset by the ebullition of the fluid. The ring-handle of the cruet enables the device to be removed from its boiling-case for cooling. After the operation the cruet can be replaced in the case, which is first emptied of water; in this way the bottles can be kept sterile for use at each successive dressing." The teapot-shaped *conjunctival irrigator* (Fig. 38) and tray (Fig. 39), also of Elliot's pattern, are most serviceable. The irrigator can be filled with saline, and sterilised on a gas-ring before operation.

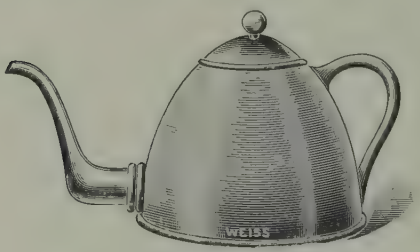

Fig. 38.—Teapot Irrigator for Conjunctival Sac.

Sterilisation of Instruments.—The blunt instruments

may be placed in trays and sterilised by boiling. It is highly important that the tray should be of such a type that no water is retained in it after removal from the steriliser, and that it allows the water to be shaken off the instruments after sterilisation. Its floor should be made of a wide-meshed gauze, and, if the tray is used as an instrument rack during the operation, it should be furnished with feet which will raise it off the surface on which it stands. If only one or two cataracts are operated upon in a morning, it is preferable to sterilise the cutting instruments in absolute alcohol, since repeated boiling is likely

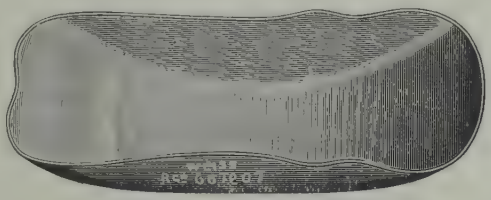

FIG. 39.—Irrigator Tray, made with recess for the Zygoma.

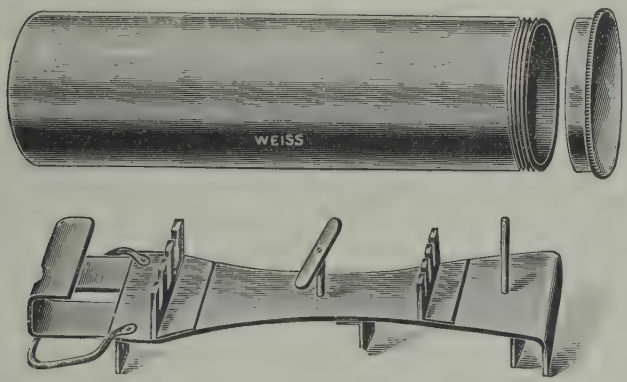

FIG. 40.—Case in which to keep Cutting Instruments immersed in alcohol.

to injure their edges to some extent. Convenient cases (Fig. 40) are made which are filled with absolute alcohol, and the cutting instruments, placed in a rack, are stored and carried in these. When many operations are performed in a morning, and relays of instruments are required, it is better to place the instruments in a suit-

able rack and to sterilise them by boiling them in rain-water, which has been rendered alkaline by the addition of a pinch of bicarbonate of soda. If care is taken only to use rain-water, the edges of the instruments will not suffer perceptibly. It should be noted that distilled water does not appear to be so suitable for this purpose.

Since no instrument should be introduced into the eye more than once without being resterilised, it is advisable to sterilise, and have ready, a duplicate of every instrument which is likely to be required. If this precaution is observed, long pauses during the operation, whilst an instrument is being resterilised, may often be avoided.

Fig. 41.—Mouth Mask.
(From Elliot's *Care of Eye-cases.*)

The Surgeon.—Since nothing touches the eye except the operation-ends of sterilised instruments, it would, at first sight, appear unnecessary for the eye surgeon to use the same measures of precaution in preparing himself for the operation as a general surgeon does. Although excellent results have been, and are, obtained by surgeons who are not very particular in this respect, yet there can be no doubt that it is the duty of the surgeon to eliminate, as far as possible, any source of sepsis. *The surgeon's hands* should be thoroughly scrubbed and disinfected before the first operation—as carefully as if it was intended to perform a laparotomy; care must be taken, however, not to use powerful disinfectants which might interfere with the delicacy of touch. The hands are carefully dried on a sterilised towel before touching the instruments. If the hands are prepared in

this way for the first operation, a rapid scrub, followed by a thorough drying, will be sufficient preparation for subsequent operations. The use of gloves is scarcely desirable, as they interfere with the delicacy of touch which is so essential.

The surgeon should wear a *sterilised apron* in accordance with the principles of aseptic surgery. The use of a *mouth-mask* is of undoubted value, since it may often be necessary or desirable for the surgeon to speak during the operation (Fig. 41).

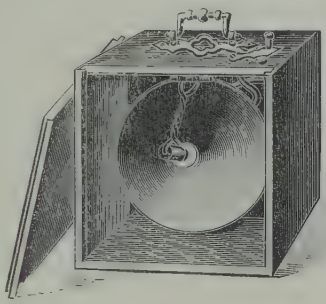

Fig. 42.—Parabolic Operating Lamp, fitted with Dry Battery in Box.

It is advisable to have a means of artificial illumination always ready at hand, and some surgeons make a practice of using combined daylight and artificial light. The writer can recommend a parabolic Klaar forehead light for this purpose. A lamp made on this principle, lit by a small dry battery and complete in a wooden box, can now be obtained (Fig. 42). It is necessary for the assistant to exercise a little judgment in focusing and directing the beam of light when the lamp is being used. Failing such a lamp, an ordinary torch lamp will prove fairly satisfactory—provided the battery is a fresh one.

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CHAPTER IX

COMBINED CATARACT EXTRACTION

Stages of operation—Section—Control of orbicularis—Iridectomy—Capsulotomy—Madras method of capsulotomy—Delivery of lens—Complications during delivery—Smith's lid control—Spoon delivery—Toilet of wound—Dressings—Complications during operation—Vitreous escape—Expulsive hæmorrhage—Partial collapse of globe—Duties of the assistant—Description of lid control.

The Combined Capsulotomy Operation for senile cataract may be divided into five stages : (1) The section, (2) the iridectomy, (3) the capsulotomy, (4) the delivery of the lens nucleus and cortex, and (5) the toilet of the wound. If any one of these has a more important bearing on the success of the operation than the others, it is the section ; this should be well placed, should be of sufficient, but not of too great a size, and should be made without injuring the eye unnecessarily.

1. **The Section.**—After having arranged the patient upon the operating table, and having prepared his eye in the manner previously described (p. 84), the blades of the speculum are introduced directly into the conjunctival sac, great care being taken to ensure that they do not touch the edge of the lids in the process. Not uncommonly, at this stage, the patient shows an inclination to throw his chin up in the air, and finds it difficult to alter this position ; this is a very inconvenient attitude for the surgeon. The faulty position will usually be rectified if the head is raised higher by placing a second pillow under it. The eyeball is next fixed by the conjunctival forceps ; in order to obtain a good grip, they should be applied at right angles to the surface of the globe near the corneo-scleral margin,

since the tissue here is firmer and more closely attached to the globe. It is a common error of the novice to apply the forceps obliquely, at an acute angle, in which case they do not obtain a good hold, and are likely to tear through the membrane. If the conjunctiva is fixed in the lower segment (which will generally be found the most convenient

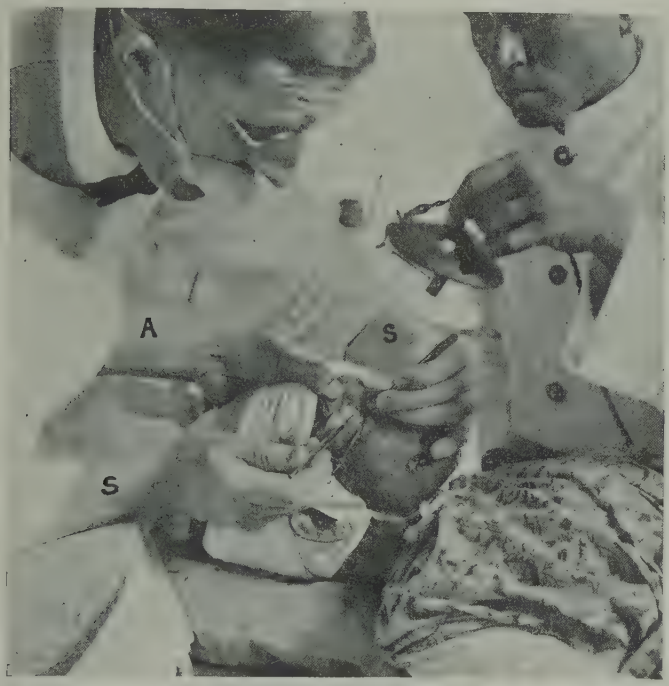

Fig. 43.—The Section. The surgeon's right forearm is supported upon a block, and the tips of his ulnar fingers rest upon the side of the patient's head. The assistant, with the thumb of his left hand, pulls the upper fibres of the orbicularis muscle above the superciliary ridge, and thus minimises the danger of squeezing.

site), the hand should be well sunk so as to avoid interference with the light ; to ensure this, the forearm and wrist should be passed well forward, the wrist should be bent sharply, and the fingers should be spread out as much as possible and supported upon the chin and face (Fig. 43).

The knife is now taken in the other hand, and its point laid against the limbus at the site of puncture. Before engaging the point, *the plane in which the ring of the limbus lies should be noted*, and the plane of the knife-blade tilted forward slightly so as to lie at an angle of about 5° to it, if it is intended to make a corneo-scleral section. The site of the puncture will vary according to the size of the section and the type of flap which it is proposed to make ; but a general rule for a corneo-scleral section, in an average right eye, is to enter in the limbus at 9 o'clock and emerge at about 2.30, the cornea being regarded as a clock-face with the 12 situated at the junction of the upper quadrants. In the left eye the corresponding points would be 3 and 9.30. If it is proposed to make a conjunctival flap, the puncture may be made slightly further out and higher up, with the counter-puncture to correspond. The hand which makes the section should be supported by resting some part of it or its fingers on part of the patient's head or face. A very useful device, still further to increase steadiness, is to rest the forearm upon a pillow, or on a wedge-shaped block, which is placed alongside the patient's head. The block can be made with a rack, which will allow its height to be adjusted to suit varying circumstances. It is covered by a sterilised towel when in use.

The knife should be held *very lightly*, and all movements of it should be made *by the fingers only*. Provided it is moderately sharp, and pressure is properly applied in the plane of the blade, the knife will almost find its own way through the tissues ; all pulling and force should be avoided during the section—this can only be done by cutting in the proper plane. It is not uncommon for a beginner to imagine that the edge of his knife is blunt, when the trouble is really due to his trying to cut with the side of the knife instead of the edge. No haste need be displayed when making the section, provided no undue violence is employed. If the eyeball is pulled about, and pressure in the wrong plane is being used, the iris may ride over the edge of the knife ; if this occurs, it is best to disregard the accident and cut straight on ; it will probably cause

no great harm beyond making the coloboma irregular and ugly. When about to make the counter-puncture, *i.e.* to cause the point of the knife to emerge from the chamber, it is well to remember that, owing to refraction, it appears to be nearer the surface than it really is. If it is desired to make it emerge at the corneo-scleral margin, a vestige of iris should still be visible between the point of the knife and the angle of the anterior chamber as the point engages in the tissue for the purpose of making the counter-puncture. Until some experience has been acquired, it is wise to err on the side of making the section too large rather than too small, since a small wound may make the delivery of the lens difficult or impossible. When making the puncture, it is necessary to make sure that the knife really enters the chamber, and that it does not merely pass on embedded in the layers of the corneal tissue. Such an accident not only makes an ugly scar, but may render the delivery of the lens impossible by much diminishing the size of the section.

When the counter-puncture is completed, the blade is moved forwards and upwards, with the lightest possible touch, until the heel of the knife has reached the temporal margin of the wound. In this movement the point of the knife is directed upwards so that more tissue is cut on the nasal side than the temporal. If the section is not completed in one cut, the movement is reversed, more tissue now being cut with the proximal part of the blade ; this will generally be sufficient to complete the section, but if it is not, to-and-fro movements are made until the whole blade of the knife emerges from the wound. A section which is completed in one or two movements appears the most " brilliant " ; but sawing movements need not be feared, provided that the knife is held lightly and allowed to find its own way. The novice need never hurry over his section, if he avoids gripping the knife, and cuts in the proper plane. The way in which the blade emerges from the wound is a good test as to whether the section has been made properly ; this should be entirely free from any jerk, and the surgeon should be scarcely conscious, from the feel of the knife, that it has done so.

The patient's eye should be allowed to take the natural position whilst the section is being made, provided it does not turn to the nasal side or roll round. It is not difficult for the surgeon to adapt himself to the movements of the eye *if he watches the plane of the ring formed by the limbus.* As a matter of fact the patient will generally look straight in front, and this is the position of least strain. If the patient is very nervous and strains badly while the section is being made, the assistant should pass his hand over the surgeon's arm and hold the orbicularis over the superciliary ridge with his thumb. In the case of a patient who strains badly, and who has an exceptionally bulging eye, it may be well to dispense with the speculum altogether, and to ask the assistant to separate the eyelids by pulling the upper part of the orbicularis over the superciliary ridge, and the lower part below the lower margin of the orbit.

Some operators of large experience use the right hand to make the section on the right eye, and the left hand for the left eye. The great majority of surgeons find a difficulty in using each hand with the same degree of delicacy, and a useful method of training the fingers of the weaker hand in fine movements is to practise it by writing, by cutting food at table, and by using scissors with it. If the operator be very right-handed, the section on the left eye may be made with the right hand, the position being altered to face the patient. The use of the wedge-shaped block, or of a pillow, will be found to give valuable help in this position.[1]

It will depend upon the inclination of the individual surgeon whether the section is made so as to cause the blade to emerge in the cornea, or at the corneo-scleral margin, or just behind this margin, taking a flap of conjunctiva. He may, if he wishes, form a conjunctival flap in combination with a corneo-scleral section, by regulating the plane of emergence of the blade.

[1] The writer at one time always used his left hand to make sections on the left eye; but, subsequently, finding them quite as easy to make with the right hand, decided to give the patient the benefit of the better hand, and now always uses that hand for both right and left eyes.

A conjunctival flap has the advantage that it seals the wound quickly, so that the risk of iris prolapse is lessened and post-operative infection is not likely to occur. Its disadvantages are—(1) That it is likely to bleed if adrenalin is not used; (2) that it obscures the field of operation, and interferes with manipulations; (3) that it may get in the way of instruments, and be cut off; and (4) that it may carry infection into the eyeball if it should be displaced into the chamber during the operation. A very useful form of conjunctival flap is a large one which is left attached at its upper margin, so as to form a bridge between the cornea and sclera, beneath which the lens can be delivered and any necessary instrument introduced into the eye (p. 163). A " sliding conjunctival flap " may be fashioned if desired. A corneo-scleral section has the advantages—(1) That it is easy to make, and leaves no scar; (2) that it is made in well-nourished tissue, and lies well; and (3) that it gives good room, and does not interfere with manipulations. A corneal section is made in tissue which is easily cut; but it leaves a visible scar. This is a very minor matter as the scar, unless the layers of the cornea have been split by the knife instead of cut at right angles to the surface, is small and almost imperceptible. The edges of a corneal wound will not lie as well as a corneo-scleral one unless made exactly right, and the margin for error is smaller in consequence; it also requires a wider base in order to allow of a section with a sufficient aperture for the escape of the lens nucleus. The healing of corneal tissue is likely to be slower than that of scleral or corneo-scleral tissue, since the nutrition of the cornea is less active than that of the latter tissues.

Great care should be taken to avoid causing any pressure upon the globe with the fixation forceps whilst the section is being made. It is very easy to make such an error, since the attention of the surgeon is concentrated upon the movements of the knife, and he is thus very apt to overlook any faulty action of the other hand.

During all manipulations subsequent to the section, *it is of the highest importance to control the action of the*

orbicularis muscle. This is effected by lifting its upper fibres over the superciliary ridge, and holding them there with the ring and little fingers of the left hand; the assistant meanwhile holds the speculum well off the eye with one hand, and, when possible, pulls the lower fibres of the muscle down, and holds them beneath the inferior margin of the orbit, with the thumb or finger of the other hand. This manœuvre will make it difficult or impossible for the patient, to squeeze out vitreous, however much he may strain. A violent contraction of the orbicularis

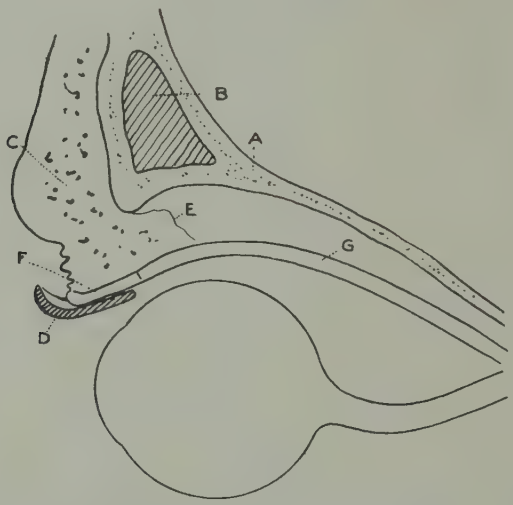

FIG. 44.—Diagram to show the position of the levator palpebræ muscle when the speculum is introduced; the orbicularis is uncontracted, or its contraction is unresisted by the speculum.

muscle must always be dangerous as long as the tarsus is anchored by the blade of a speculum. If the upper tarsal plate is rigidly fixed by the speculum, the orbicularis is able to exert considerable pressure upon the tissues attached to the upper margin of the tarsus. In this connection the levator palpebræ muscle is of the utmost importance, since it lies like a band along the upper surface of the globe. The bony origin of the muscle forms a fixed point at one extremity, and if its insertion is rendered

another (owing to fixation of the tarsal plate by the speculum), then any contraction of the orbicularis will press the muscular band of the levator on to the posterior segment of the eyeball, and tend to bring about a vitreous escape. For this reason it is important that the blades of the

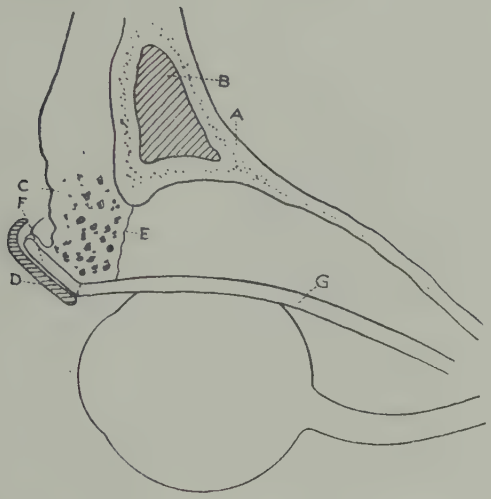

FIG. 45.—Diagram to show the position of the levator palpebræ muscle when the orbicularis contracts against the resistance of a speculum, the blades of which are prevented from closing by the action of a stop. The anterior portion of the muscle is advanced, and the posterior portion presses upon the globe. The eyelid tends to become everted. The danger of vitreous loss will be increased if the patient looks downwards.

A, roof of orbit; B, frontal sinus; C, orbicularis palpebrarum; D, speculum; E, septum orbitale; F, tarsal plate; G, levator palpebræ.

speculum should not be fixed by the action of a screw stop (Figs. 44 and 45).

2. **Iridectomy.**—If it has been decided to perform an iridectomy, the iris forceps is now taken in the left hand and the scissors in the right. There are, naturally, many variations in the technique for the performance of an iridectomy during the extraction of cataract; but the object of every surgeon is the same, namely, to excise a

strip of the iris so as to form a narrow, but efficient coloboma. The technique practised in the Madras Ophthalmic Hospital only requires simple instruments, is easy to carry out, and renders efficient service (Fig. 46). It is as follows : The surgeon takes an iris forceps, with fine blades and a wide curve, in his left hand; in his right he takes a pair of ordinary, small, straight-bladed scissors ; the thumb is passed through one ring of the handle and the ring finger

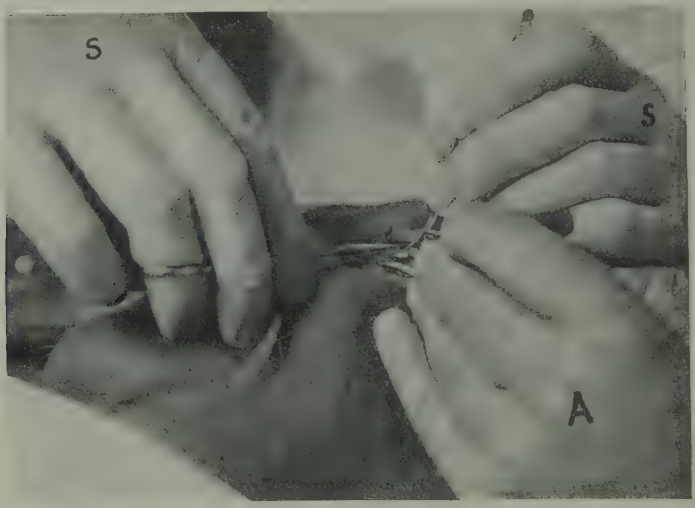

Fig. 46.—The Iridectomy.

(From Elliot's *Tropical Ophthalmology*.)

through the other ; the hold of the ring finger is strengthened by a light pressure of the first and middle fingers on the shank of the scissors. The assistant holds the speculum well forward, and catches the conjunctiva in a fixation forceps ; the hold is taken near the counter-puncture in the right eye, and the puncture in the left. The surgeon holds the iris forceps between the thumb and first two fingers of his left hand, and controls the orbicularis with the ring and little fingers of the same hand ; he now places the scissors in position ready to cut the iris, resting the tips of the fingers upon the face over the maxillary bone, and

holding the blades so as to cut in a sagittal direction ; the tip of the iris forceps is next introduced into the wound by making a light pressure against its lips ; the pupillary margin of the iris falls between the blades, which are gently closed and withdrawn, and the iris is divided by a single vertical snip of the scissors. The lightest possible hold should be taken of the iris, as it is a sensitive structure, and the patient is likely to make a sudden movement should it be gripped tightly ; this may cause it to be torn away, or may impact it in the angles of the wound, from which position it may prove difficult to dislodge. *The greatest care should be taken not to brush the blades of the iris forceps against the edge of the lid as it is being introduced.*

If the lens nucleus is a small one, and the cortex very soft, some little difficulty may be experienced in grasping the iris, should the capsule have been cut as a preliminary step. This is due to the lens, or some part of it, slipping in front of the iris before its time. Under such circumstances the iris can usually be caught if the forceps are introduced on their side, and a little sweeping movement made with the lower blade ; if this is not effective, the iridectomy may be performed after the nucleus has been delivered, or it may be omitted, as this type of case is specially suited for the simple operation, since the sphincter has not been unduly stretched. A similar difficulty is occasionally met with in the case of Morgagnian cataracts, should the fluid cortex have been evacuated before iridectomy. The iris falls back upon the shrunken nucleus, and may not be easy to lay hold of. The difficulty is met in the same way as above.

If the patient is very unmanageable, and inclined to roll his eyeball upwards, it will be wise to dispense with conjunctival fixation altogether, and limit the duty of the assistant to holding the speculum forward. Once it has been adopted, an excessively rolled-up position is generally maintained without alteration, and it is easier and safer to deal with the iris in this position, with such a patient, than to attempt to drag the eye down by conjunctival fixation forceps.

3. **Capsulotomy,** or laceration of the anterior part of the lens capsule, is generally the next step in the operation, provided it has not been done before with the needle or the knife. The capsule may be ruptured by a cystitome, or as much as possible of the anterior surface may be torn off by a pair of capsule forceps. The principle to be observed is to make as large an aperture as possible, and at the same time to beware of tearing off small shreds which might become entangled in the wound and lead to after-complications. The cystitome is entered on the flat, then turned so as to bring its point against the capsule, and any variety of aperture, which the operator favours, is made. Capsule forceps are used in a similar fashion, being introduced closed, and the toothed surface then turned towards the capsule, of which as much as possible is removed in their grip. It is hardly necessary to observe that, if capsule forceps are used, care should be taken to avoid entanglement of the iris in their grasp.

When the cataract is hypermature and the capsule much thickened, some difficulty may be experienced in cutting through it. In such a case it is useful to steady the lens by light pressure with a curette over the lower part of the cornea ; the capsule may then be cut either by a knife or cystitome. Any thickened and opaque portion can be pulled out by an iris forceps after the lens has been delivered. When "fishing for capsule" in the anterior chamber with iris forceps, particular care must be taken to avoid entanglement of the iris in the teeth or elbow of the instrument. If the possibility of such an accident is borne in mind, it is not likely to occur ; but should it do so, a serious irido-dialysis will result which will necessitate a careful trimming of the torn membrane.

In Madras, a special method of capsulotomy is practised,[1] which was introduced by the late Colonel Drake-Brockman. It consists in lacerating the capsule by a discission needle before the section is made and the aqueous evacuated (Fig. 47). That the custom has advantages is proved by its survival

[1] This method of capsule laceration was practised by the late Sir Anderson Critchett, between the years 1876 to 1881.

for over thirty years, during which time it has been tested by many different operators. To obtain its full benefit, it is essential that the pupil should be well dilated, so that a full view of the anterior layer of the lens capsule may be obtained. The needle is passed into the chamber at exactly the same spot as it is proposed to introduce the knife subsequently, and a laceration, of any particular

FIG. 47.—Laceration of the Capsule.
(From Elliot's *Tropical Ophthalmology*.)

pattern desired, may then be made, in perfect view of the operator, by the point and cutting edge of the needle.[1] The ability to see every detail of the step is a great

[1] The writer is accustomed to make a T-shaped aperture, the horizontal limb of which lies about three-quarters of the way up the anterior surface of the lens, the vertical limb reaching as low as possible; this ensures a wide aperture, whose flaps are not likely to float up into the wound. It must be confessed, however, that the most carefully designed aperture is liable to dislocation by the passage of the lens through it.

advantage, and at the same time the size and nature of the lens can be investigated. Other good points about this method are that, should the patient strain violently after the section is completed, the lens nucleus will be ejected instead of vitreous, the latter being protected by the posterior layer of the lens capsule, whilst there is no hindrance to the expulsion of the nucleus ; it is possible also to use a knife whose point has passed the first blush of youth. The Madras method of capsulotomy has proved so satisfactory to those who have had any large experience of it, that it is difficult to understand why it is not used more freely. It is possible that surgeons fear loss of aqueous whilst using the needle ; but this is an extremely rare event, and should it happen, the chamber can easily be refilled by placing the nozzle of the irrigator against the needle aperture and letting a stream run into it. The needle should, of course, be held as lightly as possible, since a firm grip with violent rotatory movements might cause a loss of fluid. An objection has been urged that the fluid, which escapes from a Morgagnian cataract, may fill the chamber and obscure the view, but such fluid always falls to the bottom and leaves the upper half of the chamber clear ; in fact, its only effect is to make the chamber deeper, and so render the section more easy.

4. **The Delivery of the Lens** is the next step in the operation. Pressure towards the centre of the eyeball is made by a curette on the lower part of the cornea just above the limbus. The upper edge of the lens is thus tilted forwards and appears in the wound, the lips of which gape slightly ; the direction of the pressure is now altered so as to push the nucleus upwards, and it is soon made to deliver by gentle stroking movements of the curette. If it hangs in the wound, a light touch at each angle will cause it to emerge.

The exact method of delivery carried out in Madras is as follows : The surgeon holds the orbicularis muscle above the superciliary ridge with the fingers of his left hand (Fig. 48). The assistant pulls the cheek downwards with the fingers or thumb of one hand, and lifts the speculum forward with the

other. The surgeon takes a curette in his right hand, and makes a light stroking movement on the sclera behind the upper lip of the wound, so as to press the upper margin of the lens downwards through the rent in its capsule. As the lens slips downwards, the pillars of the coloboma spread out or, if no iridectomy has been done, the pupil becomes oval in

FIG. 48.—Delivery of the Lens. The orbicularis is controlled above by the fingers of the surgeon and below by the index finger of the assistant, who, at the same time, holds the speculum forward with his other hand.

(From Elliot's *Tropical Ophthalmology*.)

shape. *No further step is taken until this change is observed.* He now carefully ascertains the plane in which the ring formed by the limbus lies, and, laying the curette over the lower quarter of the cornea, makes a light pressure perpendicular to this plane. It will be found occasionally that one pillar of the coloboma is more displaced than the other, or that the pupil, if intact, has formed an oval whose axis is not vertical. This is a sign that the lens

nucleus has rotated slightly on its vertical axis. In such case the pressure with the curette should not be applied over the vertical axis of the cornea, but slightly to that side of it on which the lower pole of the pupil or the least displaced pillar lies. If these steps are carried out correctly, only the lightest pressure is required to cause the upper edge of the lens to appear between the lips of the wound. As the lens emerges, the direction of the pressure is altered to an upward one towards the section, and the lens is followed on its course.

This technique not only enables the lens to be delivered with the minimum of pressure, but it also dislodges the cortex surrounding the upper part of the nucleus, which might otherwise be driven upwards and prove difficult to displace, even with the irrigator.

If preferred, counter-pressure may be employed to assist the delivery of the lens nucleus. A curette, (or the closed blades of a conjunctival forceps), held in one hand, is placed on the sclera just above the section, whilst pressure is made, on the usual site below, by a curette held in the other hand.

Should difficulty be experienced in delivering the lens nucleus, it will usually be found to be due to one or more of three causes, namely : (1) The section has been made too small to allow the nucleus to pass forwards, or (2) the capsule has not been properly lacerated, or (3) the nucleus has slipped upwards and become lodged under the shelf formed by the upper lip of the wound, and so its upper edge cannot present. If the section is too small, it may be enlarged by passing a scissors blade into the chamber and making a clean cut at one of the angles. A large nucleus can often be delivered through a small section by applying light pressure to its lower edge, so as to cause the wound to open slightly, and then transfixing it on a Bowman's needle. By using gentle pressure below, and rolling the lens over with the needle, it can often be wheeled out without injury to the eye under circumstances where a quite unjustifiable amount of pressure would be necessary to deliver it in the ordinary way. The lens is pulled out

more than pushed out. To force a lens nucleus through a wound, which is too small for it, is, however, always objectionable. Not only are the edges of the wound bruised, and their vitality lowered in consequence, but particles of lens matter are likely to adhere to their surfaces and lead to complications in healing. It is always wiser to err on the side of making the section too large than to make it too small.

Should the untorn capsule be a cause of difficulty, it may be ruptured by a cystitome, or, if very thick, cut by the blade of a Graefe knife, whilst the lens is steadied by pressure through the cornea over its lower part.

When the nucleus lodges underneath the upper edge of the wound, it may sometimes be brought into proper position by light pressure upon the scleral lip of the section ; if this fails, pressure may be applied below and counter-pressure above, but the best measure is to cause a slight gaping of the section, introduce a Bowman's needle and push the lens down with its point ; it may then be partly lifted out by the needle working from above and partly pressed out by the curette working from below. If, instead of employing the manipulations just described, pressure is continued after the upper edge of the nucleus has become impacted under the upper lip of the section, the lens will probably rotate upon its transverse axis and become very difficult to deliver. A vitreous escape is likely to occur if further pressure is applied in a faulty direction, once the lens has assumed this position.

During all the manipulations required for the delivery of the nucleus and cortex, the assistant should hold the speculum forwards off the eye with sufficient force to stretch the lids ; he should, at the same time, control the lower part of the orbicularis with a thumb or finger on the cheek, whilst the surgeon keeps the upper part of the orbicularis held over the superciliary ridge with the ulnar fingers of his left hand.

It is possible to remove the greater part of the lens cortex by massaging the eye through the cornea ; this can be done either with a curette applied directly to the eye, or

with a finger working through the lower lid ; but the use of the irrigator is, in the writer's experience, by far the most efficient method of effecting cortex removal.

Irrigation of the Anterior Chamber.—The use of M'Keown's irrigator was introduced into the Madras Ophthalmic Hospital by Colonel Elliot, some seventeen years ago, and experience there has led to its almost invariable employment as a means of clearing cortical masses out of the capsule, replacing the iris, and aiding in the toilet of the wound. The nozzle of the irrigator is held in the fingers of the right hand, and the flow of fluid is controlled by passing the tube between the first finger and thumb of the left hand ; these are used to regulate the force of the stream, whilst the orbicularis is fixed by the ulnar fingers of the same hand. A fairly full stream is played on the edge of the wound and made to enter the chamber ; whilst doing this, stroking movements are made with the nozzle from just behind the corneo-scleral margin to near the centre of the cornea. These movements are made in each meridian of the cornea in turn, and, as a result, small shreds of cortex appear in the pupil and are speedily washed out of the chamber by the force of the irrigator stream. Should a cortical mass resist being dislodged in this way, a clean nozzle may be introduced into the chamber and the stream played on it directly ; but the necessity for this will be extremely rare. When all the cortex has been removed, a stream directed on to the iris will cause its perfect replacement. By this means, evacuation of the cortex and replacement of the iris may be effected with a minimum of pressure on, or of trauma to, the ocular tissues. The irrigator has been feared as a possible source of sepsis ; but experience proves that, if reasonable precautions are exercised, this dread is quite unfounded. The irrigator, with its contents of normal saline, and the rubber tube, through which the fluid flows, should be most carefully sterilised, as previously described on p. 94, and the free end of the tube afterwards kept in a sterilised bottle until required. There is a slight risk of a leak occurring between the tube and nozzle, so that fluid may pass over the fingers

and infect the eye. This can be prevented by wrapping a piece of sterilised lint or wool round the junction whilst the instrument is in use (Fig. 49).

Many operators make a practice of delivering the lens whilst the eye is in a looking-down position, and subject

Fig. 49.—Irrigation. The junction of tube and nozzle is protected by a piece of lint. The ulnar fingers of the surgeon's left hand control the upper fibres of the orbicularis, whilst the index finger and thumb regulate the flow of fluid through the india-rubber tube. The assistant holds forward the speculum and controls the lower portio n of the orbicularis muscle.

the patient to a course of training to teach him to look down when required; but it is very doubtful whether this is at all desirable. It is inadvisable to fuss patients, and many of them will be worried if they think that they will be required to carry out special directions at the time of operation, while not a few are quite incapable of such co-operation. There is also a greater danger of vitreous

escape when the patient turns his eye downwards. The action of the inferior rectus, pulling on the lower segment of the opened eyeball, tends to make the section gape, whilst the action of the superior oblique on the posterior segment tends to force the vitreous forwards into the wound, so that an escape is probable if the patient squeezes at all hard. The looking-up position is certainly the safest for delivery of the lens, and the patient will generally assume this if left to himself. There can be no doubt that it is the duty of the surgeon to adapt himself to the patient, and to learn to make the lens present in any position of the eye which the latter assumes. *This is easy enough if the surgeon fixes his attention upon the ring formed by the limbus, and applies his first pressure at right angles to the plane in which this lies ;* once the upper edge of the nucleus has tilted forwards into the wound, the direction of pressure is altered to follow it on its course.

If the patient persists in squeezing and rolling his eye round, the speculum should be removed and Smith's lid control, or some modification of it, as described below (p. 125) should be substituted (Fig. 51). Lid control, of this description, prevents the patient from squeezing the eyeball by orbicular contraction, moreover the hook, in drawing forward the lid, carries with it the orbital connective tissue, which has attachments to the aponeurosis, check ligaments, capsule of Tenon and ocular muscles. The posterior pole of the eyeball is thus sucked towards the apex of the orbit carrying the vitreous body with it. The danger of vitreous escape is greatly diminished in consequence. This most valuable technique was described by Colonel Smith of Jullunder in connection with intracapsular expression. He uses a single lid hook for the purpose ; but a double one is used in the Madras Ophthalmic Hospital, as it gives more room without any apparent disadvantage.

In very rare instances it will be found necessary to introduce an instrument into the globe, in order to deliver the lens nucleus. This is likely to happen (1) in the case of a previously dislocated lens, in which vitreous has presented

before the nucleus has been delivered, or (2) when a similar accident has occurred from any other cause. The vectis and Pagenstecher's spoon are the instruments usually employed, and of these, the spoon is to be preferred, since there is no danger of a small nucleus slipping through it. It will be found advantageous to make a sharp forward bend on the shank of the instrument, about $\frac{1}{4}$ inch above its head, and a similar bend backwards, $\frac{1}{4}$ inch farther up, so that, when the double bend is completed, the shaft lies on a plane parallel and anterior to its original one. If bent in this way, it is easy to introduce it into the eyeball, or to manipulate it, without making undue pressure on the edge of the lid.

When it has been decided that a spoon delivery is necessary, the speculum is removed from the eye, and lid control, after Smith's method, substituted. The patient usually rolls his eye up and steadfastly maintains this position. The spoon is passed into the upper fornix, the handle being held horizontally. The instrument is now slipped into the wound and passed behind the lens, if this can be seen ; if not, it is passed well back into the vitreous humour behind where the lens is thought to be ; with the same movement the handle is brought to the vertical meridian, and then a forward and upward sweeping movement made. The nucleus is thus caught between the spoon and the deep surface of the cornea and gently withdrawn. If due care is taken, vitreous loss rarely takes place ; but efficient lid control is essential for its safe performance. After delivery the toilet of the wound may be carried out as usual.

During the removal of the cortex, a sudden dilatation of the pupil, combined with a change in colour to an extreme blackness, is a danger signal which indicates that a vitreous escape is imminent. On the receipt of such a warning, the speculum should be removed and lid control substituted. Should vitreous present, the pulling forward of the upper lid on the hook will often draw it back into the globe. Should it actually escape, the upper lid is at once well dragged forward on the hook, or retractor, and

the edges of the wound are cleared. It will often be necessary to cut the vitreous away with scissors to do this thoroughly. The iris, which has usually been either prolapsed or folded back, should be carefully replaced. If the lid is well controlled, it may often be possible to remove cortical fragments by the use of a very gentle stream from the irrigator without causing a further escape of vitreous.

The pupil of an eye, from which a vitreous escape has occurred during a cataract operation, has a characteristic appearance, unless the vitreous prolapse has been thoroughly reduced and the iris replaced. This is due to the folding back of the iris which occurs. The lower margin of the pupil describes a wide curve and the iris is seen to be shaped like a crescent, the inverted pillars of the coloboma (if one has been made) forming the horns (Fig. 50).

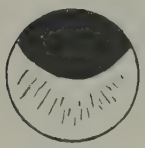

Fig. 50.—Distortion of the pupil, following a loss of vitreous in the course of an operation for cataract.

5. **The Toilet of the Wound.**—If the delivery of the nucleus and removal of the cortex have been uneventful, the next step in the operation is the "toilet of the wound." This consists in replacing the iris, so that the pupil becomes central, and in clearing tags of capsule and remnants of cortex from the lips of the incision. These objects may be effected in the simplest and most gentle manner by the use of the irrigator stream, which will be found extraordinarily efficient for the purpose. If there is any doubt whether the edges of the wound are perfectly free from capsule and cortex, or whether the iris is in good position, an iris repositor may be introduced into the wound, the section cleared, and the iris replaced. The iris spatula will be found to be easier to use if its extremity is bent so that the last 2 mm. form an obtuse angle.

As an additional measure of the toilet, it often will be found most useful to close the patient's lids and to massage the section gently, rubbing through the upper lid in a horizontal direction. This drives the iris well back, clears the section, and brings the edges of the wound into

good apposition. The eye should be kept well closed whilst doing this, and the external canthus pulled outwards in order to prevent inversion of the edge of the lid and the consequent danger of infection thereby.

After completion of the toilet, atropine is instilled and the dressing applied. Atropine is useful at this stage in spite of the fact that it may not exert its full effect until the chamber is formed. After its use, the pupil will often be found wide on the second day, even though the chamber may be empty.

Dressings and Bandaging.—The dressing used at the Madras Ophthalmic Hospital is a piece of sterilised lint laid smooth side down on the eye. This is covered by a pad of sterilised wool. If desired the pad may be soaked in a 1 to 5000 solution of perchloride of mercury, as recommended by Colonel Maynard. The wet pad appears to give very even support to the parts, and to be comfortable to wear, but the perchloride of mercury irritates some skins. The bandage described on p. 83 is then applied. One end is laid across the dressings, its extremity being passed through the corresponding ear aperture, where it is folded back and fixed by a pin, and the other end passed over it and pinned in place.

It is worth noting that a middle-aged surgeon may sometimes find that his sections and manipulations are not being executed with the same accuracy as formerly, and in such case it is well for him to remember that there is such a thing as presbyopia, and to have a suitable pair of glasses fitted for operating work! If he does this, he will be saved from losing confidence when it is necessary to operate upon a difficult case.

Complications During Operation

Vitreous Escape.—A vitreous escape may occur immediately after the completion of the section—(1) if high tension is present, or (2) if the patient squeezes violently. An escape at this stage is, however, rare, and will seldom occur if the lens capsule has been ruptured

as a preliminary measure, since the lens nucleus is then more likely to be expelled than the vitreous. Should a loss occur before the delivery of the lens, lid control must be substituted for the speculum, and the lens must be delivered by a spoon or vectis as previously described (p. 119).[1]

Expulsive Hæmorrhage.—This is a disaster which fortunately is very rare.[2] Expulsive hæmorrhage is predisposed to by the presence of high ocular tension or by the existence of degenerative changes in the walls of the choroidal vessels. The hæmorrhage most commonly occurs directly after the section has been completed. The lens is seen to emerge from the wound and to deliver itself, leaving a jet-black pupil. Immediately after the escape of the lens, the lips of the section are separated by a bulging mass of clear vitreous, which wells up and delivers itself on to the cheek ; the expulsion of the vitreous mass is accompanied by a stream of blood which flows freely over the face, and the grey membrane of the retina may sometimes be observed protruding from between the edges of the section. In rare instances the hæmorrhage may first appear after the operation has been completed, and the patient has been put to bed ; its occurrence is then signalised by the onset of severe pain, and by the appearance of blood upon the dressings.

Once severe hæmorrhage has set in the case is hopeless, and the eye must be looked upon as lost.

The hæmorrhage can usually be stopped by the use of gauze packing, firm pressure, and ice compresses ; but eventually it will be advisable to enucleate or to eviscerate the eye.

Partial Collapse of the Globe.—In old and emaciated patients the cornea will sometimes be found to fall in and

[1] In 2311 extractions performed in the Government Ophthalmic Hospital, Madras, during the years 1915, 1916, and 1917, the percentage rate of vitreous loss was 2·5. In 2781 cases operated upon in the years 1918 and 1919, the rate was 2·36 ; these include many cases in which the lens had been previously couched.

[2] It was met with four times in 2731 operations for cataract at the Madras Hospital.

to leave a deep cup on the anterior surface of the eye after the section has been completed and the chamber has emptied. In these circumstances some slight difficulty may be experienced in causing the lens to present, but delivery can soon be effected if a little counter-pressure is employed. An alarming degree of collapse of the globe may occasionally be observed after the delivery of the lens in such cases, even when there is no suspicion of any vitreous loss; but this never seems to affect the after-course of the case injuriously, and the eye rapidly regains its shape as the aqueous reforms, or as it is refilled by a stream from the irrigator. Collapse of this kind has been attributed to the excessive use of cocaine; but it often appears to be due to a senile change in the vitreous humour. It is especially common in eyes which have been subjected to couching, and these often have a shrunken vitreous and an excessive quantity of aqueous. Vitreous loss during operation is comparatively rare in eyes which undergo collapse. This is equally true of those which have been couched at some prior date, and of those which have not previously been submitted to any form of operation.

THE ASSISTANT

The aid expected by individual surgeons from an assistant varies considerably. The operation can often be performed in perfect safety, with practically no assistance, if the patient is quiet and the eye well-shaped; but should it prove difficult, success or failure may largely depend upon the manner in which the assistant is able to control the lid pressure. If the surgeon is fortunate enough to have a good assistant,[1] he will be wise to take every possible advantage of the fact.

[1] The surgeon practising in the East is fortunate in this respect, for he will find that, not only are the regular members of his staff easily trained to help him, but that a quite unskilled man, who has a sufficiently light touch, may soon be rendered a most capable assistant. This is due to the large number of cases handled, and to the fact that Indians of the lower classes have more delicate fingers than Europeans of a corresponding station.

The principal duty of the assistant is to prevent improper pressure on the globe by an instrument or by the orbicularis palpebrarum, whilst avoiding any interference with the hands of the surgeon. As a rule his help will not be needed during the making of the section; but, should the patient strain badly at this time, he can often prevent dangerous pressure if he passes his hand over the surgeon's arm and wrist, and holds the orbicularis over the superciliary ridge with his thumb (Fig. 43).

The iridectomy is a delicate step in the operation, and trouble may result if the patient squeezes and moves his eye during its performance. The assistant can often help considerably, if he holds the speculum well forward off the eyeball with one hand, whilst he steadies the eye by conjunctival forceps held in the other. The speculum (from which the stop screw has been removed) is held between the first finger and thumb, the finger being rested on the side of the face. Care must be taken to lift the speculum forward as a whole, and not merely to elevate the end held in the fingers, as the latter movement would cause the blades to press upon the eyeball. Extreme care should also be taken to avoid rotation of the speculum on its long axis resulting in one blade pressing on the globe.

The conjunctiva is gripped close to the limbus, just above the puncture in the left eye, and above the counter-puncture in the right. A firmer hold can be obtained close to the limbus, and there is less tendency to make the section gape, and to disturb the parts, if the forceps are applied above the level of the section.

The assistant's duties, during the delivery of the lens matter, will ordinarily be limited to holding the speculum off the eye, and to controlling the fibres of the lower part of the orbicularis below the inferior margin of the orbit. The easiest way of doing the latter is to pull down the tissues with the thumb and press them firmly against the malar bone. It is advisable to place a layer of sterilised wool between the thumb and cheek so as to prevent the former slipping. The assistant should be prepared, at any

time, to substitute Smith's lid control for the speculum if necessary. For this purpose he takes his position on the left side of the patient, holding the lid hook or retractor between the first finger and thumb of his right hand. He first pulls down the lower part of the orbicularis with his left thumb, covered by a layer of sterilised wool, and holds it firmly in position ; he next lays the nail surfaces of the ulnar fingers of his right hand against the tissues covering

Fig. 51.—Smith's Lid Control.

the upper margin of the orbit, and lifts them from beneath the border to above the superciliary ridge. At the same time the hook is carefully passed under the upper lid, which is lifted upon it. The orbicularis is now fully under control, and the patient is unable to squeeze. If a vitreous escape threatens, the handle of the hook is slightly depressed and the lid dragged forward at once. It is part of the duty of the assistant to anticipate the occurrence of such complications ; he should, in fact, be a second pair

of hands to the surgeon. Whilst controlling the lids in the manner described, the assistant must be careful to keep his wrist and forearm raised, in order to avoid interference with the hands of the surgeon, who should be able to pass his left hand beneath the right wrist of the assistant without difficulty (Fig. 51).

CHAPTER X

TREATMENT AFTER OPERATION FOR SENILE CATARACT

Effect of confinement—Ambulant treatment—First dressing—Attention to state of digestion—Use of goggles—Treatment of complications—Panophthalmitis—Iritis—Delayed healing—Iris prolapse—Vitreous prolapse—Capsule impaction—Detachment of choroid—Spastic entropion—Mental disturbances—Glaucoma after cataract extraction—Causes and treatment.

The manner in which a case of cataract is treated after operation is of the very greatest importance, since the future sight of the patient may depend upon careful management, and upon the speedy recognition of the onset of any complication.

In the case of a healthy patient, with a clean and uninfected eye, on which a well-executed operation has been performed, the less interference there is the better. The essentials are—(1) To prevent violent movements, such as might lead to a sudden emptying of the anterior chamber, on the part of the patient during the first few days; (2) to protect the eye from injury; and (3) to keep the pupil in a condition of dilatation rather than contraction.

During the first twenty-four hours the patient should be kept in bed in a state of perfect rest, and should have both eyes bandaged. Whether it is advisable to insist on a longer period than this will depend upon the circumstances of the case, and the surgeon must be guided by the temperament and age of the patient. The ideal might possibly be to keep the patient on his back with both eyes bandaged for at least ten days; but this would be dangerous except in the case of a person with the circulation of a Hercules and

the temperament of a log of wood. The greater number of operations for senile cataract are performed upon aged people, who are unable to support the recumbent attitude for any length of time without incurring serious danger.

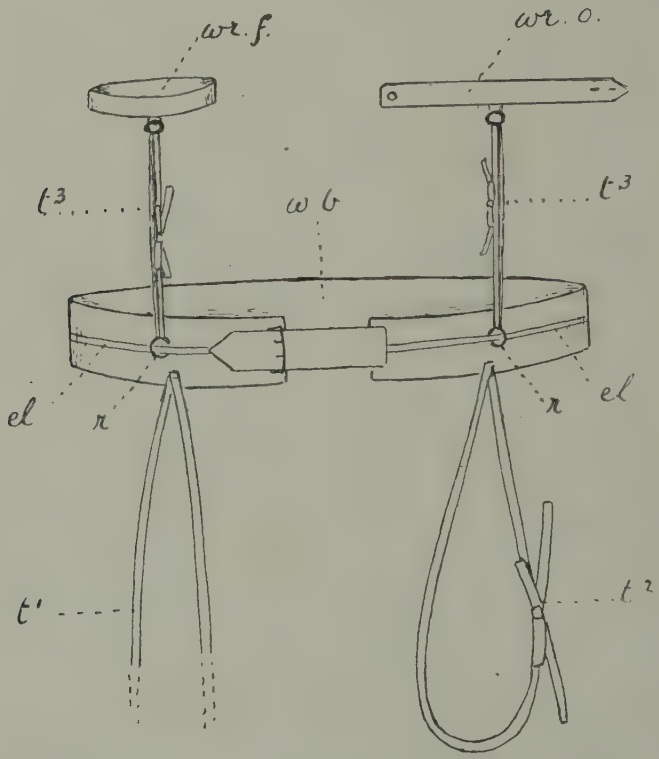

FIG. 52.—Cataract Belt. *w.b*, waistband ; *wr.f*, waistband fastened ; *wr.o*, waistband open ; t^1, tape to go round right thigh (shown unfastened) ; t^2, tape to go round left thigh (shown tied) ; t^3, tapes for waistbands ; *r*, rings to run along elastics (*el*).

(From Elliot's *Tropical Ophthalmology*.)

Such people do not bear disturbance of their usual habits well, and the excitement of the operation and the bandaging of both eyes is very apt to have a bad effect on their mental condition. A good rule to adopt, when dealing with an old person, is to release the unaffected eye and allow

the patient to be propped up in bed at the end of twenty-four hours. He should leave his bed on the third day. Even this may prove too rigorous, and it may be well to put him in a sitting posture, propped by pillows, from the first day. It may be noted that some experienced surgeons treat their patients as ambulant cases, and allow them to walk about freely and to return to their homes immediately after the operation ; but few would recommend this procedure if it could by any means be avoided. It is wise, if possible, to keep the patient quite still, lying on his back, for five hours after the operation. During this period he should only be allowed to speak in monosyllables.

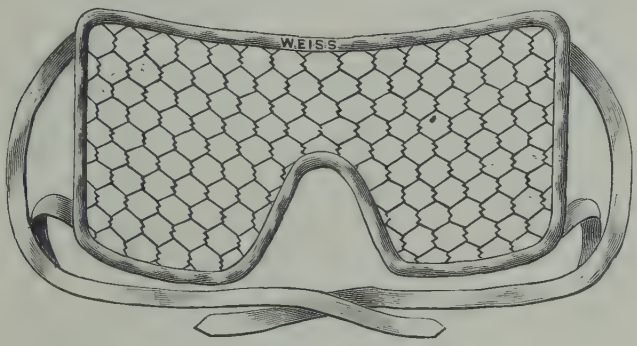

Fig. 53.—Fuchs' Wire-gauge Shield.

It is advisable, if the patient is not unduly worried by it, to tie his hands together loosely during the hours of sleep, so as to prevent him suddenly rubbing the eye when he wakes up. Many an eye has been seriously injured, and not a few have been lost, owing to neglect of this simple precaution. It is very difficult, even for an exceptionally watchful nurse, to prevent an accident of this nature occurring. The hands should be tied in such a way as to allow the patient to bring them together, and to turn over in bed without restraint, when he wishes to, but he should not be able to raise them above the level of his chin. The object can be attained by tying each wrist to an extremity of a bandage, of suitable length, which has been passed under the bed or round its foot. A contrivance,

which fulfils the same object, is the cataract belt described by Colonel Elliot (Fig. 52). Further protection to the eye may be afforded by fastening a shield, formed of wire gauze or cardboard (as recommended by Gifford), over the

Fig. 54.—Cardboard Shield for protection of Eyes after operation. The shield should be made to grip tightly over each temple.

dressings (Figs. 53 and 54). Such a shield should rest firmly on each temple.

It is important that the patient should have a good night's rest after the operation, and, to ensure this, it may be necessary to administer a sedative. A dose of

sodium veronal (7 grains in a cachet) will be found to be a most satisfactory soporific.

When both eyes are blind, the unaffected eye may be kept bandaged for a longer period than twenty-four hours. In this case, provided there is no indication of trouble, it will not be necessary to remove the dressing till the third day; but dressing after twenty-four hours may be taken to be the routine custom, should a capsulotomy extraction have been performed. In the case of an intracapsular expression, it is as well not to disturb the eye until forced to do so by the restlessness or discomfort of the patient, since any squeezing of the eye, which may occur during the dressing, will increase the danger of vitreous impaction.

At the first dressing the eye should be examined rapidly, but carefully, under illumination by a concentrated artificial light. If Herbert's method of conjunctival disinfection has been employed, the lint dressing will be moist and a line of mucus, corresponding to the palpebral aperture, will be seen upon it. If the reaction has been excessive, there may be sufficient conjunctival reaction and chemosis to render the surgeon anxious until he recognises the cause; the lustre of the cornea and the healthy appearance of the iris will soon reassure him. It is highly important that the patient should not look downwards, nor squeeze his eye during this inspection; to avoid this, the surgeon should control the orbicularis by holding it above the superciliary ridge; when he has the muscle thoroughly under control, he should ask the patient to open his eye quietly and, when this is done, the light is thrown on to it by an assistant. If the pupil is not dilated, a drop of atropine solution (4 grains to the ounce of distilled water) is instilled and the eye closed quietly. If the pupil is contracted, and a cloud of opaque cortex is seen in the chamber, a second and third instillation is given, an interval of five minutes being left between each instillation. Pressure by a piece of sterilised lint or wool, over the site of the lachrymal sac, should be maintained for two minutes after each instillation. If this is done, there will be no danger of the atropine solution

passing down the nasal passages into the pharynx. Before instilling a drop, the patient should be warned to expect it, as he might otherwise squeeze his eye when the drop falls into the conjunctival sac. It is useful to prescribe aspirin in 10 or 15–grain doses, to be taken at night, if there is much cloudy cortex in the chamber. The sound eye is ordinarily released when the eye is dressed for the first time, and a single bandage is substituted for the double one.

If, at the first dressing, the pupil is found to be wide and black, and the eye quiet, the bandage may be left undisturbed for three days ; it will then be well to change the lint, as it will probably have become soiled by a little mucous discharge. A drop of silver nitrate solution (3 grains to the ounce), instilled into the eye at each dressing, has a beneficial effect, since it inhibits the growth of bacteria, keeps the conjunctiva healthy, and tends to strengthen the union of the wound edges. The silver solution should be used very freely, and allowed to flood the cheek if there is any sign of excessive meibomian secretion or eczema of the skin in the neighbourhood of the eye. If there is any hyperæmia of the conjunctiva, the instillation of weak nitrate of silver solution is practically painless. Argyrol (in a 12½ per cent. solution) may be used when hyperæmia is entirely absent. If progress is made free from complication, the dressing may be removed on the tenth day and a shade or protective glasses substituted. No exposure to a cold wind should be permitted until the wound has been thoroughly covered by epithelium. The eye should be protected from glare as long as this is felt by the patient.

During convalescence, it is necessary to pay close attention to the state of the patient's digestion. A free action of the bowels should be ensured on the third day—if this has not taken place the day after operation. It is wise to allow no solid food for at least twenty-four hours after operation ; firstly, because the movement of the face and jaws in mastication would prevent the necessary rest, and secondly, because the patient is unlikely to be able to digest much, after having undergone the excitement of the

operation. He may be given a soft diet, which does not require much mastication, on the second day, and he should be in a condition to resume an ordinary light diet by the fourth day. His tongue should be watched, and the condition of his bowels regulated during the whole period of convalescence.

Goggles.—It is often good, and seldom harmful, to dispense with the bandage and dressing at a very early stage of the after-treatment, and to use a protective goggle or shield instead. This may be used on the third, or in some cases on the second, day. The advantages of the shield are—(1) It does not encourage the growth of bacteria in the conjunctival sac, as the application

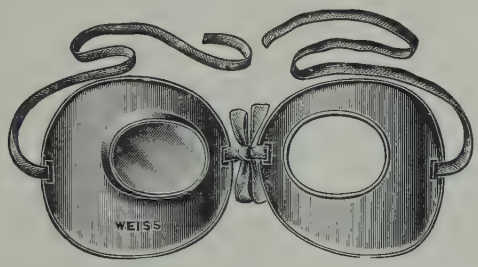

Fig. 55.—Aluminium Goggles for use after Operation.

of a bandage and dressing does ; (2) it allows free drainage to the conjunctival discharges ; (3) it permits movements of the lid, which gently massage the healing wound, and are often beneficial ; (4) and perhaps, most important of all, its effect on the mental condition of the patient is excellent. The writer has used goggles or shields in the after-treatment of about 3000 cases of cataract in Madras, and can speak highly of their use. Those he has employed have been made for him by Messrs. W. E. Smith & Co., of Madras, and can be obtained from them or from Messrs. Weiss & Co. They are made of aluminium, and are moulded to the orbital margin so as to sit comfortably over the eye (Fig. 55). [1]

[1] They may also be made of celluloid or similar material ; but aluminium was selected as it was more easy to obtain under local conditions, and was light and comfortable for the patient to wear. It is also easy to sterilise.

The centre of the shield is cut away and is replaced by amber-coloured glass, so that the patient is able to see with the affected eye, and is consequently inspirited and encouraged. The sound eye is covered by a modified shield, the whole centre of which is removed, leaving only the portion which rests upon the orbital margin. The purpose of this skeleton shield is to hold the other shield in its proper place, and at the same time to allow the patient to rub the healthy eye should he wish to do so. The two shields are joined across the nose by a bridge of tape which is tied long or short to suit the type of face. A tape, from the temporal margin of each, is passed above the ears and under the occiput and tied at one side. By judicious alteration of the length of the tape, which forms the bridge across the nose, a pair of these goggles, or shields, can be made to fit a face of any type.

Should goggles, or shields, be used, it will be necessary to dress the eye every day, as a much freer discharge flows from the conjunctival sac in that case. They should, of course, be sterilised before putting them on, or when changing them.

Treatment of Complications after Operation for Senile Cataract

The treatment of patients who heal without any complications has been dealt with so far; but, for various reasons, it cannot be expected that uneventful recovery will be the course of every case operated upon.

Panophthalmitis.—The most dreaded disaster, though fortunately a very rare one,[1] is a suppurative panophthalmitis which will probably lead to complete destruction of the eye. Its occurrence must be regarded as an indication

[1] Twelve eyes were lost from the occurrence of suppurative panophthalmitis in 5092 cataract extractions, performed during the years 1915 to 1919 at the Madras Ophthalmic Hospital. In four of the twelve cases, suppuration began later than the ninth day after operation. Herbert (*Cataract Extraction*, p. 270) has recorded 1655 consecutive extractions, in which no eye was lost from suppuration, and Elliot has reported one case of suppuration in 1000 cases of extraction.

to the surgeon that his aseptic or antiseptic technique has completely broken down at some point, either in the selection and preparation of the patient, or in the sterilisation of his instruments, or in the actual performance of the operation. In all probability the commonest source of infection is the conjunctival sac, in which virulent bacteria have lurked undiscovered. These are often derived from the lachrymal passages, whose patency should invariably be tested. The soiling of an instrument, by its having touched the edge of the lid on its way into the eye, and the passage of fluid from the fingers down an instrument into the wound, are other obvious methods of infection. The necessity for strict adherence to the golden rule, that the same instrument should never be introduced into the eye a second time without being resterilised, is so apparent that it need only be mentioned.

Signs of suppuration.—If virulent pyogenic infection is present, these signs will generally appear on the third day, though at the first dressing the edges of the wound may show some haziness, the aqueous may be slightly turbid, and the iris may appear clouded. Some pain is usually felt on the second night, and next morning, when the dressing is removed, a little muco-purulent discharge will be noticed coming from between the lids. The conjunctiva will now be seen to be injected and slightly chemosed, the edges of the wound to be definitely infiltrated, the cornea to have lost some of its lustre, and the iris to be obscured by a distinctly turbid aqueous. The destructive process makes rapid progress, and, a few hours later, the lid is swollen and drooping, chemosis is marked, and the chamber is filled by a thick yellow exudate. A profuse discharge of muco-pus flows from beneath the swollen lid. The edges of the wound soon become separated by the exudation and sloughing of the cornea occurs. The appearance of panophthalmitis may sometimes be delayed, and the writer has seen it appear on the eighth day in an eye which had been healing in a perfectly healthy manner till then. In such cases it is likely that the infection is a post-operative one.

The condition is a desperate one if the infection is very virulent, and has started in the deeper parts of the eyeball. If the infection is less severe and more superficial, and if an efficient treatment is instituted without delay, it may be possible in a few cases to save a little vision.

Treatment of panophthalmitis.—The objects in view should be—(1) To relieve the vascular congestion, so that a free circulation of blood may be restored ; (2) to clear the lymphatics and induce a free flow of lymph ; and (3) to disinfect the tissues as much as possible without inflicting excessive injury. A free purge and the application of three or four leeches to the temple will tend to reduce the congestion, and the flow of lymph will be encouraged by the injection of 10 to 20 minims of a solution of cyanide of mercury (equal parts of a 1 in 2000 solution of cyanide of mercury and 1 per cent. solution of acoin) under the conjunctiva. Constant eye-baths of a saturated solution of magnesium sulphate should be used for the same purpose, all dressings, except a shade, being removed from the eye to allow free drainage. Internally, urotropin may be given freely in doses of 15 grains every three hours. Care should be taken to administer an abundance of water or barley water, in order to lessen the irritating effect of the drug on the urinary tract, and the urine should be examined at frequent intervals for the appearance of blood or albumen. If the source of infection appears to lie in the section, its edges should be thoroughly cauterised with the actual cautery. Treatment on these lines may sometimes be successful in aborting the infection and preserving some degree of useful vision ; in the vast majority of cases it will subdue the pain and enable the patient to retain his eyeball, even though it may be sightless ; this is a distinct consideration in dealing with patients, such as are common in the East, who resent the mutilation of removal, and who are unable or unwilling to keep an artificial eye in order, even should they have the means to purchase one.

If the inflammation does not yield quickly to treatment, the eye should be eviscerated. This procedure is safer than any form of enucleation, as the latter opens up lymph

spaces by which inflammation may spread to the membranes of the brain. The operation is a very simple one, and, as it only takes from thirty to sixty seconds to do, general anæsthesia under ethyl chloride or nitrous oxide suffices. A sharp knife (a disused Graefe is excellent for the purpose) is thrust through the sclera, just outside the limbus, and the whole disc of the cornea is rapidly excised, either by cutting round its periphery with the knife or by enlarging the incision with scissors. The contents of the eye are next removed with a spoon (Fig. 56), taking care to leave no uveal tissue behind; the movement, which is quite a simple one, resembles that used when eating a boiled egg with a spoon. The interior of the cavity is then swabbed out with a 1 per cent. solution of biniodide of mercury, and afterwards freely irrigated with a 1 in 3000

Fig. 56.—Evisceration Scoop.

solution of the same drug. A simple aseptic dressing is applied after the completion of the operation. The procedure is simple and safe, and it leaves an excellent stump for an artificial eye; its sole disadvantage is that convalescence is more prolonged than in the case of enucleation. It is, of course, of the highest importance to remove every vestige of uveal tissue.

Iritis.—Iritis, which in its graver forms spreads backwards and involves the ciliary body, is probably the most common of the serious complications met with in the after-treatment of cataract operations. The cause, in most cases, is an infection which occurs at the time of operation; but it may sometimes be derived from the surface of the wound, and is occasionally endogenous. Its onset is favoured by any condition which debilitates the patient, such as diabetes, pyorrhœa, and gastro-intestinal disturbances, and by the presence of lens matter in the anterior

chamber. A mild infection, which would be easily resisted by the cells and fluids of a healthy patient, or by those of one whose iris and lymphatics were not overburdened by the disposal of adventitious lens matter, may gain a footing in an eye under such conditions, and may diminish or destroy vision. Infection will vary in virulence and in dosage, and the resulting inflammation will correspond in intensity, so that, if the virulence and dosage are low and the resistance is high, the inflammation may be merely sufficient to be recognised as such, and perhaps to cause the formation of a fine web on the capsule. If, however, the conditions are reversed, the inflammation will be intense, and will result in the formation of a dense membrane which will obscure the pupil and seriously interfere with vision. Should the ciliary body be severely involved, the pupil may be completely blocked and drawn up into the scar. The more severe grades of infection lead to a chronic state of inflammation in which periods of increased tension may be present, and it may prove necessary to enucleate the eye, in order to avoid risk of sympathetic disease, and to relieve the patient of pain.

Symptoms of iritis may appear about the third day, or may be postponed for quite a long time ; but as a rule they may be expected within the first ten days, if they should appear at all. Iritis, which occurs within the first four days after operation, is probably always due to an infection at the time of operation ; but the source of the later types is quite likely to be autogenous. The treatment of the condition will naturally be influenced by these facts. The onset of iritis is usually signalised by discomfort or pain in the eye and headache ; but a close observation at the previous dressing will probably have warned the surgeon that all is not quite as it should be. The earliest signs are a lack of dilatation of the pupil combined with slight lachrymation and ocular congestion, whilst careful observation may show a loss of definition in the markings of the iris. If the complication is not treated at once, the signs become more marked and a grey haze is seen in the pupil area. The pupil not only resists dilatation, but it actively contracts.

In bad cases all the signs become accentuated ; keratitis punctata may appear, and the anterior chamber may fill with a curdy exudate.

Treatment of iritis.—The use of atropine, a saline purgative, and a few doses of acetyl-salicylic acid will usually soon cause the pupil to become wide and black and the eye to become quiet, provided that the infection is mild, that the resistance of the patient is good, and that treatment is undertaken at once. A subconjunctival injection of 20 minims of normal saline solution will help the absorption of inflammatory exudates. More radical measures are, however, necessary in the severe types of inflammation. The congestion of the eye should be reduced by the application of leeches to the temple ; atropine or some other mydriatic should be used freely, in order to dilate the pupil if possible. In this connection it is very important to keep on the alert for any signs of atropine poisoning or atropine irritation of the conjunctiva, and, if necessary, to substitute hyoscine (which may be used in a $\frac{1}{2}$ per cent., or, more carefully, in a 1 per cent. solution). It is frequently advisable to combine the use of atropine and hyoscine when a maximum dilatation is desired ; the combination of drugs often appears to be more effectual than when one is employed singly. Dionine is a useful help in subduing the iritis, as it both encourages lymphatic drainage and allows a freer absorption of the mydriatics by the flushed conjunctival vessels. Another way in which the action of atropine may be intensified is to instil adrenalin and cocaine solutions along with it. The subconjunctival injection of cyanide of mercury is of great value in the condition, and may be repeated after an interval of five or six days. It is well to remember that the injection should be made as superficially as possible, since the reaction is likely to be excessive and absorption much delayed, if the deeper episcleral tissue is damaged. It is advisable to inject the solution under the conjunctiva covering the upper part of the globe, so that a conjunctival flap may be formed below without undue difficulty (the site of election in an aphakic eye, having a coloboma above),

if a sclero-corneal trephining should be required subsequently.

The constitutional condition of the patient will require close attention and, if any defect is recognised, this should be remedied without delay. The state of the gums, nasal passages, teeth, and tonsils must be carefully investigated, and the whole gastro-intestinal tract must be brought into a healthy state. If there is any history of venereal disease, or if there is a positive Wassermann reaction, active anti-syphilitic treatment should be carried out. Even when there is no special indication, the free use of acetyl-salicylic acid, of salicylate of soda and of mercurials is advantageous.

Delayed Healing.—The anterior chamber, in the great majority of cases, is fully formed on or before the third day ; but delay in healing occasionally occurs. This may sometimes be due to orbicular spasm, or to deficiency of healing power on the part of the patient's tissues ; but in by far the greater number of instances it is caused by the impaction of iris, lens, cortex, capsule, or vitreous in the section. The presence of impaction will be pointed to by the limitation of the leak to one spot which is surrounded by a grey haze of infiltration. If the iris is involved, only a small knuckle is usually impacted. This will often recede if mydriatics are used and free lid-movement is allowed. An angle of the wound is a favourite site for iris impaction. Cortical matter may also disappear if the same treatment is adopted, but capsule and vitreous impaction may cause considerable trouble, and it may be necessary to attempt to remove the former. Vitreous impaction often leads to considerable irritation and photophobia ; it is likely to set up a form of keratitis at the edge of the wound, and is a grave danger to the eye, since it may prove a cause of irido-cyclitis or glaucoma.

Treatment of delayed union.—Nitrate of silver (3 to 5 grains to the ounce) has proved itself a useful drug in the treatment of delayed union, whatever the cause of the latter may be. It keeps the conjunctiva clean, and tends to strengthen the union of the wound. The drops should be instilled daily. When healing is delayed, union will

frequently take place quickly, if the bandage and dressings are removed and a shield substituted. This is probably due either to the removal of foreign matter from between the lips of the wound by the movement of the lids, or to the disappearance of orbicular spasm. The use of a shield is most valuable in the treatment of orbicular spasm; but a careful watch should be kept on such patients as are inclined to open their eye very widely and expose a line of sclera above the cornea, since there is a risk that these may evert the flap by catching its edge on the lid margin. Constitutional treatment should not be neglected, and proper attention should be given to feeding the patient, and to the administration of suitable tonics. It has long been recognised that an extraction wound, which has been slow to close, will heal rapidly after the performance of an iridectomy. Such an operation is likely to free the lips of the wound from any tags of capsule or other tissue.

Striate Keratitis.—Striate keratitis is met with occasionally. This may appear during the first week as a series of fine, grey, vertical lines of opacity in the cornea. It is probably due, in most cases, to injury received by Descemet's membrane during operative manipulations and during the passage of the lens nucleus. The injury, inflicted by forcing a large, hard nucleus through a small wound aperture, is a common cause of the condition. The opacities usually clear, in the course of a few days, without giving rise to any trouble. The use of dionine and subconjunctival injections of normal saline will hasten their absorption. The complication is seen less and less as the experience of the surgeon increases.

Iris Prolapse.—Prolapse of the iris is a complication which may have serious remote results, and may be expected in about 1 per cent. of cases. It is, of course, more commonly seen when a simple operation has been performed than when an iridectomy has been done. A faulty section and an imperfectly replaced iris are predisposing causes, and it is more likely to occur in those patients who have bulging eyes and who persistently strain and look downwards,

especially if they have a flaccid iris. Sudden movements, which rupture the union of the wound and allow a gush of aqueous to wash the iris into the section, are usually the exciting cause, but the prolapse may also result from an injury. Iris tissue may also be pushed into the wound by the swelling of immature lens cortex, which has been left in the eye at the time of operation. If prolapse occurs, it is usually seen within the first week, and most often about the second or third day. The area involved may be very small and nearly imperceptible, or the prolapsed tissue may almost fill the section. The small prolapses are by far the most common. A prolapse of the iris, by lying between the lips of the section, may interfere with the healing of the wound, or it may form a channel by which infection can reach the deeper parts of the eye and cause iritis and cyclitis. If allowed to heal in the wound, it may prove a source of late infection or of glaucoma (p. 150).

Treatment of iris prolapse.—If the prolapse is small, it will sometimes recede without operation. If it is situated in the upper region of the section, atropine will be useful. If the eye is a prominent one, a firm bandage should be applied ; but in other cases it is often beneficial to remove the dressings and use a shield. Most often, however, the prolapse will require to be excised. Excision of prolapsed iris, soon after a cataract extraction, is a critical proceeding, as the eye does not bear handling well in the early stages of healing, and a prolapse of the vitreous may easily occur. The closure of the conjunctival sac for some hours by a dressing affords an opportunity for bacterial growth and, if any of the exposed iris is returned into the eye, it may carry infection with it.

When it is decided to remove the prolapse, all preparations should be made as for a major operation. The conjunctiva and prolapsed iris are very thoroughly anæsthetised by cocaine combined with adrenalin. (It may be advisable to administer a general anæsthetic to a very nervous patient.) The eye is exposed by Smith's method of lid control, or, if a speculum is used, this must be held well forward by the assistant. The conjunctival

fornices are then thoroughly flushed out with normal saline solution. The protruding iris is next gently seized with a pair of iris forceps, is withdrawn as far as possible, and is snipped off as close to the wound as can be managed. All iris tissue is next cleared from the site of the prolapse by introducing an iris spatula. After the operation is completed, atropine is instilled and the eye dressed. If preferred, the actual cautery may be used to remove the prolapse. The protruding tissue is thoroughly burnt away by the cautery, which is used at a dull red heat, and at the same time the surrounding edges of the wound are slightly seared. When all the tissue is removed, and the wound surfaces disinfected, the cautery is heated for the second time and allowed to cool ; the point is then used to replace any iris tissue which remains in the section.

Provided the prolapse is not a cause of active trouble, it is often good practice not to remove it immediately it is detected, but to postpone the excision until such time as the greater part of the wound has united. Such postponement not only diminishes the risk of vitreous prolapse at the time of excision, but also allows the conjunctiva to be brought into a healthy condition by the use of a shield. It will, however, be found more difficult to clear the iris tissue from the wound when an excision is undertaken some time after the prolapse has occurred. In this case it is advisable to use a Graefe knife or keratome to clear the protruding tissue from the edges of the wound, and to pay special attention to the angles of the aperture, as the iris is often firmly impacted into them. The actual cautery may be used in the same manner as in the case of a recent prolapse.

Vitreous Prolapse.—Vitreous prolapse may sometimes occur when a patient is exceptionally restless, or has an unusually prominent eye, or it may be caused by an injury. It is, of course, more likely to occur if the vitreous body has been severely strained at the time of operation. Different grades of the condition may be met with, from that in which the vitreous is slightly impacted in the section, to that in which the lips of the wound, in its whole

extent, are widely separated by a bulging mass of vitreous humour.

A small prolapse may occur at any time within the first eight days after operation; but it seldom does so later than the fourth day. The presence of vitreous, between the edges of the wound, prevents proper union and excites an inflammatory reaction. Irritability of the affected eye, excessive photophobia and lachrymation are the consequences. On examination, the conjunctiva is found to be injected, and a clear bead of vitreous may sometimes be visible in the section. If the prolapse has existed for any length of time, its situation will be marked by a grey haze of infiltration in the neighbouring cornea. The anterior chamber may be unformed or, if no rapid leakage of aqueous is occurring, it may be shallower in the neighbourhood of the prolapse. Convalescence will be much prolonged as a result of this complication. The inflammatory reaction is likely to cause the formation of a membrane which extends from the section into the vitreous humour; this may interfere with vision by forming a variety of secondary cataract, or it may prove a cause of glaucoma by obstructing filtration. The prolapsed vitreous may form a path by which infection can enter the eye, and so lead to a persistent and dangerous form of irido-cyclitis. This latter may be of such a nature as to necessitate removal of the eye, in order to avoid a sympathetic inflammation of the unaffected eye. Vitreous prolapse will probably cause a high degree of corneal astigmatism, even if no more serious trouble results.

The *principles of treatment* are—(1) To attempt to reduce the prolapse, and to prevent its extension by the pressure of a bandage applied firmly over the dressing; (2) to subdue any iritis by the use of atropine, hyoscine, dionine, subconjunctival injections, etc.; (3) to guard against infection of the conjunctiva. Under such treatment healing may take place and be followed by nothing more serious than corneal astigmatism; but it will sometimes be necessary to excise or to cauterise the prolapsed tissue, and to attempt to clear the section. This may be

done in much the same way as when dealing with an iris prolapse, but in this case it is well to cover the gap left after excision by a sliding flap of conjunctiva.

Large Vitreous Prolapse is fortunately rare, and is mostly found in those patients whose eye is very prominent, and who are inclined to open it widely and look down, leaving a line of sclera visible above the cornea. This attitude causes pressure on the posterior segment of the eyeball, and forces the vitreous forwards ; the section is likely to gape, owing to the strain on the cornea, whilst the edge of the upper lid is in danger of catching on the margin of the flap and causing its eversion. This is a complication which is not likely to occur if even weak union of the wound edges has taken place, and it is seldom seen after the first dressing. The section is seen to gape widely, and the aperture to be occupied by a clear black substance. The corneal flap appears grey owing to infiltration of its substance. This is a very serious complication as it will certainly lead to considerable loss of vision; but the condition of the eye is by no means hopeless, and it may attain useful, though not good sight.

Treatment.—If the patient is nervous and restless, it is best to give a general anæsthetic. The conjunctival sac is thoroughly flushed with saline, and an incision is made into the projecting vitreous ; some of the latter is allowed to escape, and a very large sliding flap of conjunctiva is brought from one side, and stitched in place so as to cover the whole of the cornea. It is best to fashion the flap in such a way that it lies at right angles to the line of the section, as it will then be less liable to displacement by movements of the upper lid. A satisfactory method of making the sliding flap, is, after the incision (A, Fig. 57) through the conjunctiva at the limbus has been made, to pass the points of the scissors under the membrane as superficially as possible and, by widely separating them, to undermine the conjunctiva and dissect it from the underlying tissue. A short incision (B, Fig. 57), nearly concentric with the first, is then made at a suitable point to relieve tension on the flap. The bare area, left after removal of the flap, is covered by drawing each angle of the secondary

incision together with a suture ; this is entered near each extremity of the incision. The eye should be kept under hyoscine after the operation, and it may be advisable to give a subconjunctival injection of cyanide of mercury about six days later, in order to promote absorption of the inevitable vitreous exudations.

Capsule Impaction.—The lodgment of a piece of capsule in the section may be suspected if the chamber is slow in forming, or remains very shallow. The impacted capsule causes considerable irritation, since it acts as a foreign body

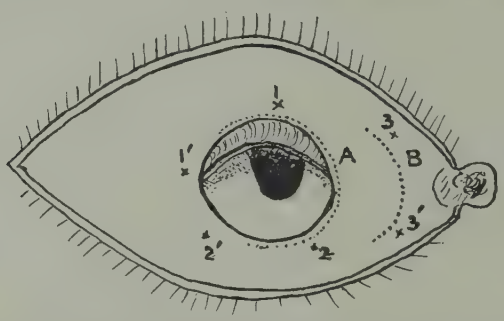

Fig. 57.—Diagram to show the formation of a sliding flap of conjunctiva for the treatment of a large vitreous prolapse with eversion of the section. A, first conjunctival incision; B, second conjunctival incision, made to relieve tension on the flap ; 1, point where suture is entered, the needle being subsequently passed through the membrane at 1′ ; 2, point where second suture is entered, the needle being subsequently passed through the conjunctiva at 2′ ; 3 and 3′, points through which a suture is passed in order to draw the nasal part of the bulbar conjunctiva over the bare area, caused by drawing the flap across the cornea.

in the wound. Signs of its presence may be found about the fourth or fifth day, when it will be noticed that lachrymation is excessive, and the chamber is either unformed or is very shallow. If the section is carefully inspected, a grey spot of infiltration will be noticed at the site of the impacted capsule. If allowed to run its course, the area of infiltration will spread until it forms a circular or oval spot, whose diameter is about 3 mm. or 4 mm., and whose edges are rather more dense than the centre. The surface of the infiltrated spot is dulled, and the pupil is generally smaller than normal. Capsule impaction is a dangerous complica-

tion, as it may prove the source of an irido-cyclitis and is very commonly the cause of glaucoma, since an inflammatory membrane, which connects with the iris or hyaloid, and interferes with filtration, is likely to develop in connection with it. The site of the impaction also forms a point from which a downgrowth of epithelium from the surface may originate, and an intractable glaucoma may be produced if the anterior chamber becomes lined by epithelium (p. 151).

Treatment.—The best treatment is prevention, and the possibility of capsule impaction should be borne in mind whilst the capsulotomy is being performed, and whilst the toilet of the wound is being carried out. The capsule should be divided in such a way as to avoid the risk of angular pieces from the margin of the aperture floating up into the wound, and it should be torn with a clean sweep of the instrument to avoid breaking off small separate fragments which might become entangled in the edges of the section. The wound should be thoroughly searched by the irrigator stream or iris spatula when performing the toilet, and, if the entanglement of any capsule is suspected, an attempt may be made to seize and to remove it between the blades of an iris forceps.

When it is decided that an impaction of a piece of capsule has occurred, it is well to remove the bandage and to substitute a shield or goggle as early as possible, since the movement of the lids may suffice to dislodge the fragment ; in any case such a measure will retard the growth of bacteria in the conjunctival sac, and so render subsequent attempts at removal safer. If the impaction persists, the eye should be cocainised and the section cleared. An attempt may be made to withdraw the impacted piece of membrane with an iris or capsule forceps, or, if this fails, to clear the wound with a spatula. Precautionary measures should be taken to anticipate the onset of iritis.

Detachment of the Choroid.—This complication has been studied by Fuchs, who suggests that minute tears occur at the filtration angle in the course of the operation, and that fluid can pass through these into the suprachoroidal space. The complication is seldom seen except

when an iridectomy has been performed. Signs of detachment appear in the first days after operation. The chamber, though very shallow, is formed, and shows no sign of leakage, whilst the ocular tension is strikingly low. No evidence of the detachment can be detected on inspection of the pupil—an ophthalmoscopic examination being necessary in order to see it. The complication is not a very serious one, since replacement of the membrane usually occurs in a few days without any special form of treatment. It is probable that the occurrence of a detachment of the choroid frequently escapes observation.

Spastic Entropion.—This is a slight, but troublesome, complication which is sometimes found in the lower lid of those old people who have very lax tissues and a deficiency of orbital fat. The inversion of the lashes produces an inflammatory condition of the conjunctiva and, in this way, predisposes to an infection of the wound. The pressure of the bandage and the irritation of the wound in the eyeball are the exciting causes, and a vicious circle is formed when the irritation of the lashes is added to the latter.

Treatment.—The first step in the treatment is to remove the bandage and to place a shade over the eyes. Even the pressure of a shield on the orbicularis is injurious. This measure may prove sufficient if, at frequent intervals, the patient everts the lid by pulling with his finger on the cheek. If the entropion continues, the lid can often be kept in proper position by the application of a piece of plaster as a strapping ; should this be ineffective, it may be necessary to use a temporary suture or to perform a small plastic operation. If it is decided to employ a suture, a horizontal fold of skin below the lower lid is pinched up between the finger and thumb. A needle, armed with silk, on which a small bead has been threaded, is thrust through the flap from below upwards ; two more beads are then threaded on the silk, and the fold is again transfixed, this time from above downwards. The points of entry and exit are on the same level, but are half an inch distant from the previous ones. Another bead is now threaded on the suture, and the ends of the latter are drawn tight and tied in such a way that each point of entry or exit is protected

by a bead. A more permanent effect may be produced, if, after the injection of a solution of adrenalin and cocaine into the skin beneath the lower lid, a similar fold of skin is completely excised and the cut edges united by sutures. In some cases it may be necessary to include a small portion of the orbicularis muscle in the excised fold.

Mental Disturbances.—Considering that the operation for senile cataract is absolutely painless, and free from any extensive injury to the tissues, the degree of mental disturbance to which it may give rise is remarkable. This is explained by the fact that the patient is of an age at which unusual excitement and disturbance of routine are badly borne. For months previously he has been in a state of partial blindness, and his hopes and thoughts have been fixed upon the operation which is to restore his vision; often, too, he has been obsessed by a dread that he may endanger his prospects of future sight by lack of self-control at a critical moment. A nervous patient lies down on the operation table screwed up beyond concert pitch, and it can be no matter for surprise that a snap may sometimes occur later, if he is laid on his back for some days with both eyes bandaged. Restlessness and wandering speech are generally the signs that mental control has broken down, and no time should be lost in releasing the sound eye, getting the patient on his feet, and ensuring a free action of his bowels. Bromides and chloral may be given, and it is also necessary to pay attention to the condition of his circulation, and to administer digitalis and stimulants if indicated; but restoration to as nearly normal habits as possible is the first essential. Here, again, prevention is better than cure, and the patient may often be spared considerable mental suffering, if the nature of the operation is explained to him, and he is assured that it is quite painless, and that no co-operation on his part is necessary except that he should remain reasonably quiet during its performance and for some days after it.

Glaucoma after Extraction.—A high ocular tension may be found shortly after the operation. This is generally due to the swelling of cortical masses which have been left in the eye at the time of operation. The swollen

matter may obstruct the filtration channels, and so lead to a rise of tension, if the wound has healed sufficiently to prevent leakage through it as the intra-ocular pressure increases. The peripheral part of the iris may be pushed forward by the swelling of cortical matter left in the posterior chamber, or it may be drawn forward by a prolapse of its tissue into the wound, or by capsular tags or by cortical fragments, which have become impacted in the section, and a high tension may be brought about in this way. Any increase in the intra-ocular pressure at this period is likely to be of a temporary nature, since the strain upon the healing edges of the section will soon cause a leakage of fluid from the wound. These cases, in which a temporary rise in tension occurs, should, however, be regarded with suspicion, since the causes of the condition may continue to exist after the edges of the wound have firmly united, and, the peripheral portion of the iris having undergone a permanent advancement, a progressive glaucoma may result.

The causes of progressive glaucoma, following the extraction of a cataract, have been studied by Priestley Smith, Treacher Collins, Elliot, and by many others. They may be considered under the following heads :

1. *A diminution or an obliteration of the filtration angle of the anterior chamber.*—A change of this nature is the commonest cause of post-operative glaucoma. This condition is mostly brought about by the iris having become impacted into or adherent to the scar. The iris is thus held forward in such a way that a great part of the membrane lies nearer the cornea than normal. Impaction in the wound of portion of the capsule, or of the anterior part of the vitreous body, produces a similar effect, since the iris may be dragged forward by these structures into the neighbourhood of the scar. In this case much of the filtration area is also likely to be covered, and to be obstructed by membranes that develop in connection with the impacted tissues (Fig. 58). It has been suggested that membranes, of this nature, may drag upon the ciliary processes as cicatrisation proceeds, and that such a drag is accentuated by the constant movements of the

iris and the ciliary muscle, so that a condition of ciliary irritation is set up, which, under suitable circumstances, may pass into an irido-cyclitis. The further forward the point of adhesion of the membrane to the cornea lies, the greater is its effect likely to be in closing the angle of the anterior chamber.

2. *A downgrowth of epithelium from the surface of the eye into the anterior chamber.*—The chamber may, in this way, receive a complete lining of epithelium, through which

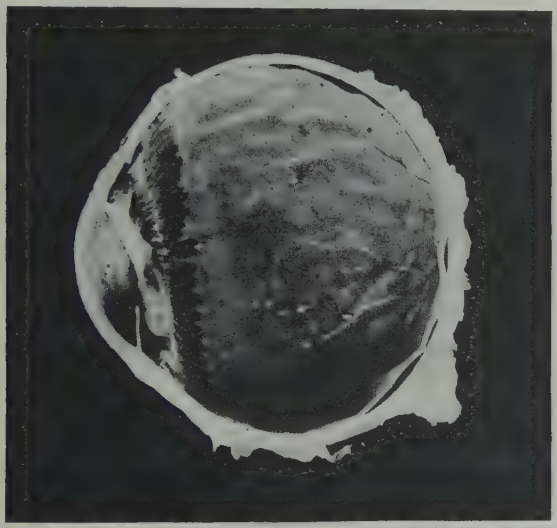

Fig. 58.—Half-section of an Eye removed for Secondary Glaucoma, due to a Synechia of Capsule and Iris, which followed a Cataract Extraction.

(From Elliot's *Glaucoma.*)

filtration will be limited, or will be entirely absent (Fig. 59). An epithelial downgrowth is favoured by delayed healing of the wound; the influence of capsular, of cortical, and of hyaloid impaction in this connection has already been mentioned (p. 140). Collins says of these cases: "The increased tension to which the cyst gives rise does not make its appearance until some months after the operation; there may be for a time good vision, so that the operation appears to have been a success. Then slowly the glaucoma manifests itself with superficial œdema and

haze of the cornea. The anterior chamber will in one part appear exceedingly shallow, where the iris is pressed forward by fluid unable to pass into it, and in another part, where the cyst is situated very deep." Glaucoma, which results from a downgrowth of epithelium into the chamber, is of a very intractable nature.

3. *Irido-cyclitis* may occasionally give rise to a post-operative glaucoma, even when the angle of the anterior chamber remains widely open. The high tension may in

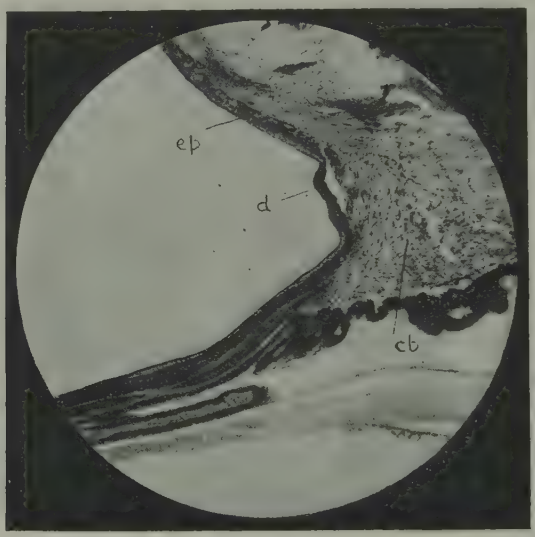

FIG. 59.—Downgrowth of Epithelium into the Anterior Chamber forming an Epithelial Cyst, and causing a Secondary Glaucoma to follow a Cataract Extraction. *ep*, lining layer of epithelial cells; *d*, area where these have become detached; *cb*, ciliary body.

(From Elliot's *Glaucoma*.)

these cases be due (*a*) to an alteration in the character of the aqueous, which renders it less able to escape through the meshes of the pectinate ligament, and (*b*) to the presence of cells of inflammatory origin, which block the channels of filtration.

4. *The presence of an annular posterior synechia* may be the cause of a rise in tension. Such a synechia is the result of a previous post-operative inflammation; in the course

of this the pupillary margin of the iris becomes bound down to the subjacent tissue, which may consist of lens capsule, or of hyaloid membrane, or of both these structures. The underlying tissues are themselves reinforced and strengthened by the presence of organised inflammatory matter. *Iris bombé* results from the imprisonment of fluid behind the iris, and the angle of the chamber becomes closed in consequence (Figs. 60 and 61).

Fig. 60.—Half-section of an Eye removed on account of Secondary Glaucoma. The pupil is blocked, and the pupillary margin of the iris is adherent to a membrane composed of the lens capsule and the anterior layer of the hyaloid, which are inflamed and matted together. The iris is bulged forward by the accumulation of fluid in the posterior chamber (*iris bombé*). A cataract had been couched in this eye.

(From Elliot's *Glaucoma.*)

5. *The presence of an impermeable diaphragm across the eye* may occasionally be the cause of a post-operative glaucoma (Priestley Smith). This is a similar condition to the last, but differs in that the inflammatory membrane, which is the cause of the obstruction, lies between the vitreous and the aqueous chambers.

Treatment of Post-operative Glaucoma.—When the high tension is associated with the presence of inflammation of the iris or ciliary body, the usual medicinal measures should be taken to reduce the congestion and the intra-ocular pressure. Frequently-repeated paracenteses of the anterior chamber will sometimes prove very helpful. Hyoscine will often be found to be more beneficial than atropine in these cases, as its use is accompanied by less ocular congestion.

Some form of operative treatment will be necessary when the glaucoma is due to other causes. A sclerotomy may sometimes be of temporary benefit; but its effect is seldom lasting, and it is usually advisable to perform

some variety of sclerectomy without delay. Sclero-corneal trephining is specially suited for these cases, since it provides efficient filtration with a minimum of disturbance of the parts, and this is naturally of the greatest importance when dealing with an aphakic eye. The writer has always found that post-operative glaucoma, which is due to a diminution or an obliteration of the filtration angle of the anterior chamber, can be relieved by a sclero-corneal trephining with a degree of certainty that he has not experienced from any other operation. Trephining is also suited to glaucoma, caused by an epithelial down-growth, and is probably the only measure that affords much prospect of relief in these intractable cases. Glaucoma, secondary to *iris bombé* and an annular posterior synechia, may sometimes be relieved by a sclerotomy or by an iridectomy; but here, again, trephining is more likely to be successful in bringing about a permanent cure. Cases, in which there is an impermeable diaphragm across the eye, are likely to prove hopeless, and a posterior sclerectomy is probably the only measure that can be of any benefit.

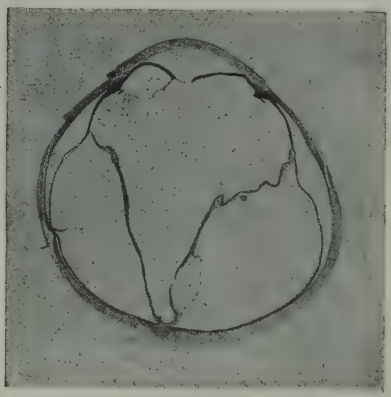

Fig. 61.—A Section of the same Eye as in Fig. 60.

When trephining an eye, on which a combined cataract extraction has been performed, it is advisable to make the trephine opening at some distance from the site of the coloboma, and the flap will, for this reason, be most often placed below. Care should be taken to make only a very small peripheral iridectomy. An escape of vitreous is very rare if the operation is carried out with ordinary precautions.

Erythropsia and Cyanopsia.—Disturbances of colour perception may sometimes occur after an operation for cataract. These usually consist in seeing objects as

coloured with a red tinge (*erythropsia*) or with a blue tinge (*cyanopsia*).

Erythropsia is a less common phenomenon than cyanopsia, and it has, in rare cases, made its first appearance some months after operation ; it is most marked on passing into a feeble light after the eye has been exposed to an excessive glare.

Cyanopsia is fairly frequent in the tropics, and Elliot found it present, during the first five days after operation, in 53·6 per cent. of 250 consecutive cases operated upon for cataract.[1]

Symptoms, of the above nature, in aphakic patients, would appear to be caused by the retina, owing to a coloration of the lens, having been deprived for a long period of radiations of one colour ; when the lens is removed, and the retina is again flooded with light, it shows an acquired hypersensitiveness to those radiations of which it has previously been deprived. The symptoms are more likely to attract attention when only one eye is aphakic, and the other eye retains sufficient vision to act as a control.

Little is required in the way of treatment, since the condition is usually temporary, and the symptoms soon disappear ; in any case the trouble will vanish once the second eye is operated upon. Smoked or tinted glasses should be worn in order to afford protection to the eyes, and, if these are used as a routine measure after the dressing has been discarded, erythropsia and cyanopsia will seldom be complained of.

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CHAPTER XI

INTRACAPSULAR EXPRESSION

Section—Iridectomy—Erect delivery of lens—Delivery by "tumbling"—Rupture of capsule—Toilet of the wound.

THE reader is advised to consult the excellent books written by Colonel Henry Smith, of Jullunder, and Dr. Derrick Vail for a full description of the intracapsular expression operation. He will find there all details of the operation, of the complications that may be expected, and of the best methods of dealing with such. It is only proposed here to give an outline of the operation, and to mention such modifications as have been found useful.

THE PREPARATION FOR THE OPERATION

This is similar to that made for an extraction with capsulotomy; but in this case, as it is not proposed to divide the capsule as a preliminary measure, no instillation of atropine is required.

The **Section** will, naturally, require to be larger in the case of this operation than in that of the capsulotomy procedure, since it will have to allow the passage of the whole lens. A very high corneal incision will probably be found to be the most satisfactory. The puncture should be made far back in the limbus, and the counter-puncture at a corresponding point on the opposite side of the limbic ring. Care must be taken not to injure the lens capsule during the passage of the knife across the anterior chamber; the depth of the section makes this a possible accident.

The tissues in this part of the globe are frequently rather tough and difficult to cut, and the section will often be found easier to make with a Smith-Wilson knife. This differs slightly from the ordinary Graefe knife, as its back is quite straight and its cutting edge slopes upwards to meet the straight back and form a long, delicate point. The long pointed blade will be found to enter the tissue with greater ease than the Graefe knife. It will sometimes, however, be found a little difficult to fashion a perfectly regular section with a knife of this shape.

The **Iridectomy** may be performed in the same way as if a capsulotomy operation was being performed ; but particular care must be taken not to injure the anterior layer of the lens capsule with the iris forceps. Colonel Smith's technique is to cause the iris to prolapse between the blades of the forceps, by pressure on the lips of the wound, with a view to avoid the danger of this accident.

So far the steps of the operation have been much the same as those of a capsulotomy operation ; but matters are different when the iridectomy has been completed. The assistant places himself on the left side of the patient, the speculum is removed and Smith's lid control is substituted. If he has not already done so, the surgeon must decide whether he will deliver the lens "erect," with its upper edge leading, or "tumble" it so that its lower edge passes through the section first. This latter method has two advantages : (1) The cornea is tucked in between the lens and the vitreous whilst the former is being delivered, and so acts as a shield, pressure upon which will force the vitreous backwards and the lens forwards ; (2) it is easier to deliver the capsule if a rupture in it should occur before the whole lens has emerged. The disadvantages of the method are—(1) That it is not suited to lenses which have a very large nucleus, and (2) that considerable pressure on the globe may be required to deliver the lens in this manner.

If it is decided to *deliver the lens erect*, the surgeon takes a Smith's spoon in his left hand, and a lens hook in his right. He does not stand directly behind the patient, but a little on the right side, and passes his left hand, holding the

spoon, beneath the right wrist of his assistant. The spoon is slipped into the upper fornix, and held in readiness ; but no pressure is made with it on the globe. The plane of the limbic ring is then carefully observed, and the extremity of the hook is laid on the lower part of the cornea, at six o'clock, in such a way that it covers 3 mm. of the peripheral part of this meridian. Pressure backwards is now made with the hook *in a direction exactly perpendicular to the plane of the limbus.* If the section is of sufficient size, the wound gapes, and the upper edge of the lens, covered by its capsule, appears. Pressure is maintained in the same direction until about a third of the lens has emerged, when it is altered to follow the lens in its passage upwards through the wound. When three-quarters of the lens has emerged, a clean hook is taken, and its concavity is laid against the nasal side of the lens, which is then gently raked out of the eyeball. Great care must be taken not to injure the capsule at this stage. If the lens ligament is difficult to rupture, a few lateral movements of the hook, as it presses on the lower part of the cornea, will often break it down and start the lens on its way. If much difficulty is experienced in making the lens present, cautious counter-pressure, made just behind the scleral lip of the wound, may be tried in combination with these movements. Counter-pressure should, however, always be avoided if possible ; it is rarely necessary if the section is of sufficient size, and if the pressure is made in the right direction. The spoon has its use if, unfortunately, vitreous should present instead of the lens ; in this case it is passed into the eye behind the lens, which is then expressed upon it and lifted by it out of the wound. Great care must be taken during this manœuvre, not only to avoid such violence as would lead to an extensive loss of vitreous, but also to avoid rupturing the lens capsule. The spoon designed by Smith is by far the best for the purpose as its edges are blunt.

The direction of the pressure is entirely different if it is intended *to tumble the lens.* The object of this manœuvre is first of all to rupture the ligament below, and then to raise the lower part of the lens and to tuck a fold of cornea

between it and the vitreous. The lens hook is embedded in this fold, and made to push the lower edge of the lens upwards, until the latter has undergone complete rotation on its transverse axis, and is clear of the section. The last remaining attachment is at the upper part of the suspensory ligament. As the lens rotates, the cornea follows behind it and holds back the vitreous.

We shall next describe the technique whereby the above purpose is effected. The point of the lens hook is laid just above the limbus at six o'clock ; sufficient pressure is exerted to dimple the surface and feel the scleral ring. When the point has engaged upon the scleral ring, pressure is made in a downward direction, as if it was intended to pull the cornea towards the patient's feet. A sliding movement, from side to side, may be made with the end of the hook if the resistance does not give way rapidly. An alteration in the direction of the pressure is made when it is felt that the ligament has broken, and that the hook has passed beneath the lower edge of the lens. The hook is now turned so as to bring its entire extremity beneath the lens, and the pressure is changed to an upward and backward direction. The lower part of the lens now appears between the gaping lips of the section, and the whole structure is pushed out of the globe, the cornea being folded beneath it as it emerges. The concavity of a clean hook may be used to deliver the upper part of the lens, which is the last to emerge. The hook is used with a raking movement as previously described. During all this time, the left hand holds the spoon in the upper fornix, ready to give assistance if required.

If the capsule ruptures whilst the lens is being delivered, an attempt may be made to grasp it between the blades of a dissecting forceps. If the accident should occur after the greater part of the lens has been delivered, one blade is passed behind the lens and the other in front of it, and an attempt is made to pull lens and ruptured capsule out together with the forceps. This attempt is more likely to be successful if the lens has been tumbled. If this fails to deliver the capsule, it may be fished for in the ordinary way, or the case may be treated as an extraction with capsulotomy.

If the delivery, erect or tumbled, is quite successful, the corneal flap will fall back into the cavity which remains after the removal of the lens and aqueous. A yawning cavern, at the bottom of which the vitreous lies, is seen. On looking into this cavern the iris may be observed hanging, like a curtain, across its lower part. The upper part of the iris is usually in close apposition to the deep surface of the upper part of the section, and some of it may actually be lodged in the angles of the wound.

The Toilet of the Wound.—The toilet of the wound is rather a more critical proceeding in this operation than in a capsulotomy extraction. The assistant holds the lid well forward in order to cause the vitreous to fall back as much as possible. The surgeon clears the iris from each angle of the wound, and detaches it from the deep surface of the upper lip of the section by the iris spatula. If this is successfully done, the iris is seen to form a keyhole-shaped diaphragm across the cavity

The irrigator will be found an invaluable aid in effecting a successful toilet. A gentle stream is played upon the angles of the wound and underneath the upper surface of the section. The iris very quickly becomes detached and hangs free in the cavity. If desired, the surgeon can fill the chamber with fluid and so place the edges of the wound in apposition ; but he need not hesitate to close the eye when the corneal flap is still depressed into the cavity, as it is floated into place very soon when the aqueous forms underneath it. The use of atropine is not only unnecessary after this operation, but it is even inadvisable. It may be admitted freely that there is less tendency to early iritis, if the iris is not taxed by the disposal of lens remnants, and the further the iris lies from the section after this operation the better. A contracted pupil or, at the most, a semi-dilated one, is therefore the most favourable.

When the operation is completed, the ordinary dressing is applied and the patient is carried back to bed. The greatest care must be exercised to keep him quiet, and to avoid any disturbance which might lead to prolapse or impaction of iris or vitreous.

CHAPTER XII

MODIFICATIONS OF OPERATION AND TECHNIQUE

Kalt's suture—Van Lint's sliding conjunctival flap—Conjunctival bridge flap—External canthotomy—Czermak's subconjunctival extraction — Dimmer's modification of Czermak's operation—Discission in senile cataract—Barraquer's operation—Operations for artificial maturation—Förster's operation—Homer Smith's operation.

Many modifications, whose purpose is to render the after-course of the case free from complication, or to cause the complete delivery of the lens in its capsule, have been introduced from time to time. It is only proposed to mention here the best known of these.

Kalt's Suture.—The purpose of this is to ensure the adaptation of the edges of the wound, and to diminish the risk of iris or vitreous prolapse during the period of healing. It is described by Kalt as follows :

"A very fine needle, armed with a correspondingly fine cotton thread, is entered from the highest part of the corneal margin, passed through half the thickness of the cornea for a distance of 1 mm. and brought out as near the limbus as possible. The needle is then passed horizontally through the episcleral tissue, and the loop of thread between the two insertions of the suture, which should be 0·5 mm. apart, is left long and turned towards the outer canthus. The ends of the thread are then carefully placed, the upper on the forehead and the lower on the cheek, and the incision is made passing between the two insertions of the thread (Fig. 62) ; the lens is extracted, and the iris is replaced by traction on the thread, assisted, if necessary, by the spatula ; the wound is closed

by pulling on the upper thread, and the suture is tied. Finally any soft débris is removed by suction. The suture is removed on the third day if the pupil dilates well; but, if there is any evidence of infective organisms in the conjunctival sac, it is taken out earlier."

Van Lint's Conjunctival Flap.—This fulfils the same object as Kalt's suture, and is thus described by Van Lint: "The operator stands on the right of the patient. By means of forceps and blunt, curved scissors he detaches the conjunctiva corresponding to the upper half of the corneal limbus. This dissection stops below at the hori-

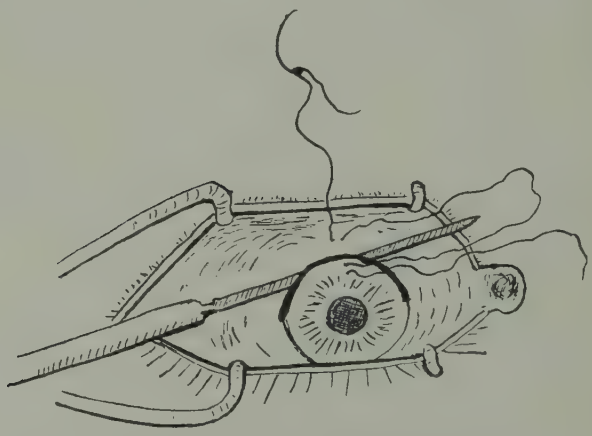

Fig. 62.—Diagram to show the insertion of a Kalt's suture.

zontal meridian of the cornea. The conjunctiva must be dissected from the sclerotic upwards to the extent of 8 mm. to 10 mm. Two silk sutures are then inserted, one on each side of the cornea. In placing the lower end of the thread, one introduces the needle beneath the conjunctiva 2 mm. below the horizontal meridian of the cornea. The upper suture is passed beneath the detached conjunctival flap to a point about 10 mm. from the place of introduction of the lower end of the thread (Fig. 63). The sutures should be placed in such a way that when they are tied, after the extraction of the cataract, the

detached conjunctival flap glides in front of the corneal wound and thereby covers about the upper fourth of the cornea." A corneo-scleral section is made and the threads on each side are tied after the cataract has been extracted and the toilet of the wound has been completed. The sutures usually drop out about the fifth or sixth day.

These measures may prove of considerable value in some cases; but they have the disadvantage that they make the operation more complicated and difficult, and that the delay in the performance of the operation, which they entail, may prove a severe trial to the self-control of the patient. The latter objection would not, of course, apply if a general anæsthetic was employed.

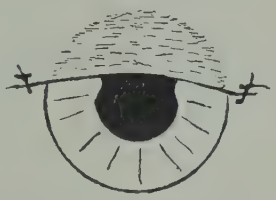

Fig. 63.—Diagram to show Van Lint's sliding flap of conjunctiva. The flap is held in place by the insertion of a stitch near each angle.

Conjunctival Bridge Flap.—This was originally used by Desmarres, recommended by Pansier and again revived by Cluckie. A very long and wide conjunctival flap is fashioned by turning the blade of the knife backwards as it emerges from the upper part of the limbus. The knife is carried upwards beneath the bulbar conjunctiva for a distance of about 10 mm. or 11 mm., and is withdrawn without dividing the upper attachment of the flap so formed. A bridge of conjunctiva is thus left, 11 mm. long and 4 mm. wide, one extremity of which is attached to the upper part of the limbus, and the other is continuous with the bulbar conjunctiva. The lens can be delivered, and the necessary manipulations can be carried out beneath the bridge so formed. The lips of the wound are kept in apposition by a flap of this nature when the eye is closed. It has the advantage that it is easy to make, and that the time occupied in fashioning it is negligible. Its disadvantages are—(1) It renders the iridectomy and removal of the lens cortex by irrigation a little more difficult, and (2) unless adrenalin is freely used, troublesome hæmorrhage from the flap may be met with. The bridge

flap is valuable in the case of very old patients, and the manipulations will be easier if the flap is made rather to one side, so as somewhat to resemble a modification of Czermak's subconjunctival operation.

External Canthotomy.—Axenfeld recommends the division of the external canthus when the eye is prominent, or when excessive squeezing of the lids is anticipated. He states that this proceeding causes no trouble, and that the wound heals readily without being sutured. If desired, a free division may be made as suggested by Vail for the treatment of cases of delayed healing of the section. The outer canthus is then divided by two incisions, one in the upward and one in the downward direction, so that the whole incision runs at right angles to the palpebral fissure.

Czermak's Subconjunctival Extraction.—The section is made below in this operation, and is started with a knife and completed with scissors. The knife is entered subconjunctivally, cutting edge downwards, in the outer part of the limbus, at the temporal extremity of the horizontal meridian of the cornea. It is passed to the centre of the pupil, is made to divide the capsule, and is then entirely withdrawn. The blade of a scissors is passed into the conjunctival aperture, and a vertical incision, about 15 mm. long, is made downwards in the membrane. The conjunctiva, surrounding the lower half of the cornea, is next undermined so as to form an extensive pouch, which reaches a little beyond the nasal extremity of the horizontal meridian of the cornea. The blade of a small, curved scissors is now passed into the anterior chamber through the aperture previously made by the knife, and, whilst an assistant raises the conjunctival flap in a forceps, the cornea is divided subconjunctivally at the corneo-scleral margin as far as the nasal extremity of the horizontal meridian of the cornea. The lens is then delivered into the pouch from which it is easily evacuated. The mouth of the conjunctival pouch is next closed by a couple of sutures.

Dimmer's Operation (Fig. 64).—The day before the operation the two ends of the corneal meridian which passes downwards and inwards at 45° are tattooed with

Indian ink. Before the operation, a few drops of cocaine solution with adrenalin are injected beneath the bulbar conjunctiva on the temporal side. With the scissors, an incision about 8 mm. long is made in the conjunctiva parallel to the tattooed meridian, and situated about 8 mm. from the limbus. A pocket, which extends from one tattooed point to the other, is fashioned by undermining the conjunctiva. A suture is passed through the edge of the flap by which the latter is raised up, so as to expose

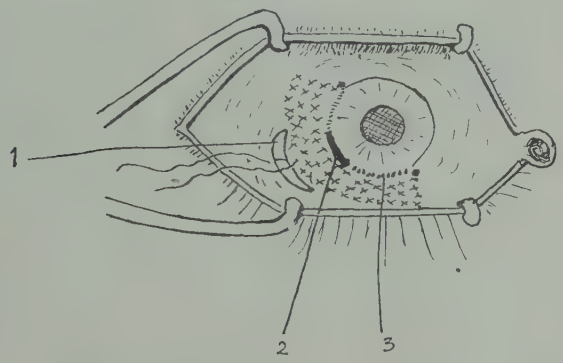

FIG. 64.—Dimmer's modification of Czermak's operation. 1, conjunctival incision; the suture has been inserted; 2, the incision made by the keratome; 3, the dotted lines show the extent of the incision, made by scissors from each extremity of the keratome incision. The area of undermined conjunctiva is indicated by a cross shading. The two dots, tattooed on the conjunctiva, are seen on the margin of the undermined area.

the corneo-scleral margin at the bottom of the pouch. A broad-pointed knife, 2·5 mm. wide, bent like a keratome, is passed into the anterior chamber, and an incision is made through the middle third of that part of the limbus which is included between the tattooed points; this incision is then extended on either side, with a special pair of scissors, as far as the tattooed spots. The capsule is now opened, and the lens is delivered. The operation is completed by closing the conjunctival opening by means of the suture.

A similar operation is recommended by Hari Shunker,

who does not perform a capsulotomy, but delivers the lens in its capsule.

Discission.—Jackson has performed the operation of discission upon patients suffering from cataract, whose age exceeded 40 years, and has successfully brought about the absorption of the lens in these cases.

The needle is entered at the limbus, passed to the edge of the pupil, and is then made to pierce the lens nucleus. Care is taken to ensure that the point of the needle reaches the centre of the nucleus, so that the aqueous may obtain good access to that part of the lens. The needle is withdrawn without making any attempt to break up the cortex of the lens. A second operation is undertaken later, and the nucleus is then thoroughly broken up into fragments.

Phakoerisis or Barraquer's Operation.—The purpose of this operation is to secure the delivery of the cataractous lens in its capsule, and at the same time to inflict the minimum of trauma upon the ocular tissues compatible with the attainment of this object. This is effected by drawing the lens out of the eyeball by means of an instrument, which is made to adhere to the surface of the anterior capsule by suction, instead of delivering the lens by pressure upon the globe ; only slight disturbance of the vitreous body is produced, and thus danger of vitreous escape at the time of operation is lessened, and the risk of after-complications, due to impaction of vitreous or iris, is considerably diminished.

The special instruments required for the operation are—(1) The "ventouse," which is practically a small hollow spoon, with rounded edges, attached to a canula. The canula fits into a handle furnished with a button, pressure upon which allows negative pressure to be communicated to the cup ; (2) an air-pump, worked in oil by an electric motor. The pump is furnished with a device which allows the degree of negative pressure to be regulated, and at the same time permits vibratory alterations to occur in it, the rate and extent of which can be adjusted to suit the particular type of cataract under operation ;

(3) a switch, worked by the foot, by which the current can be turned on and off. A negative pressure, equal to 55 or 65 cm. of mercury, is required. A small spoon, considerable negative pressure, and rapid vibrations are suited to a hard lens, and a large spoon, with a lower pressure and slower vibrations to a soft lens.

An ordinary large section is made, a conjunctival flap being usually fashioned, or a Kalt's suture or Van Lint's flap

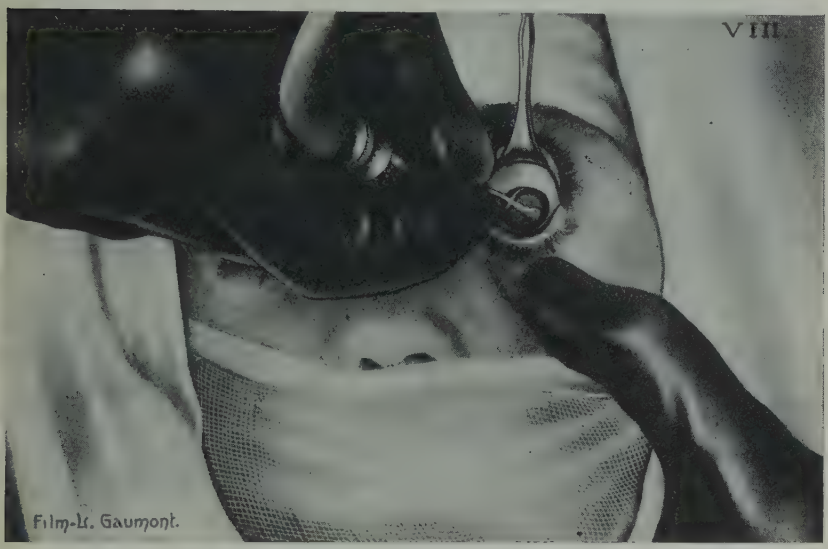

Fig. 65.—Barraquer's Operation for Cataract. The ventouse is placed upon the lower, temporal part of the anterior capsule.

(From *The British Journal of Ophthalmology.*)

may be used. Smith's lid control, or a modification of it, is substituted for the speculum. The ventouse is introduced into the wound, passed through the partly dilated pupil, and placed with the concavity of the cup lying upon the lower part of the lens (Fig. 65). The button in the handle of the ventouse is then pressed upon and an intermittent vacuum created in the cup. The fibres of the lens ligament are ruptured by the vibrations which occur in the vacuum. When the lens has been grasped by the

cup, the handle of the instrument is lifted slightly forwards, so as to rotate the lens forwards on its transverse axis (Fig. 66). As the upper part of the lens comes forward, the instrument is gently withdrawn on a plane slightly anterior to that on which it entered the eye, carrying with it the lens contained in its capsule. " In simple extraction, or in cases when a peripheral iridectomy has been performed,

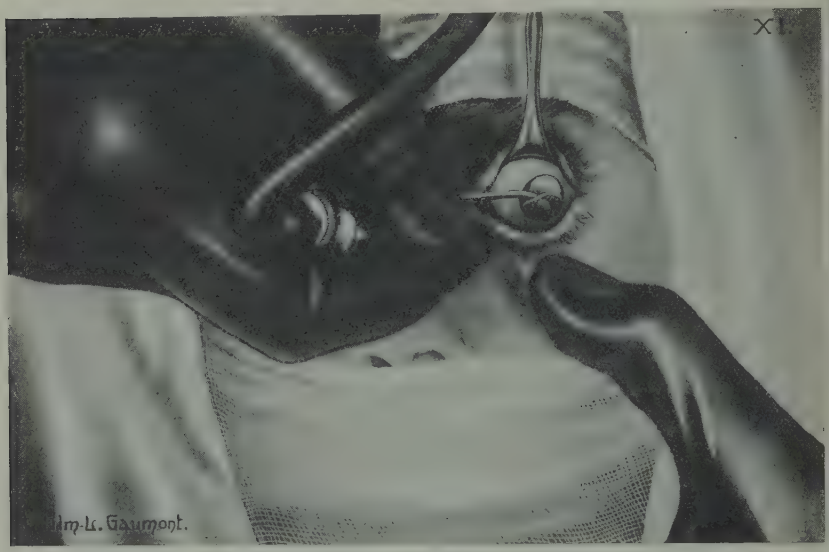

FIG. 66.—Barraquer's Operation for Cataract. The handle of the ventouse has been slightly depressed and rotated, and the lens, in its capsule, is passing through the section.

(From *The British Journal of Ophthalmology*.)

the lens is delivered by its lower border ; this is easily effected by turning the instrument so that the posterior surface of the lens faces the cornea. This is the method to be recommended, and the one in which fewest accidents are met with." [1] The patient should avoid looking down during the delivery of the lens.

[1] The upper portion of the iris sphincter, and the band of tissue, left after a peripheral iridectomy, are less liable to be over-strained, if the lens is delivered in this way.

Operations for the Artificial Maturation of Cataract

Various operations are practised with the object of producing a rapid degeneration of the lens cortex, and so facilitating the evacuation of the lenticular matter from the capsule. The efficacy of these operations depends upon the production of such an injury to the capsule as will prevent it from hindering the passage of aqueous into the fibres of the lens. The most effective are probably—(1) Massage of the cornea after a paracentesis of the anterior chamber, or after an iridectomy, as recommended by Förster, and (2) a laceration of the anterior layer of the capsule, made some hours previous to the extraction operation, as recommended by Homer Smith.

Förster's Operation.—After performing an iridectomy, the cornea is firmly stroked with a strabismus hook for two or three minutes. The capsular epithelium is thus injured and is rendered incapable of protecting the lens from the aqueous humour. Complete opacification of the lens usually follows within six weeks or two months. The massage may be carried out with a smooth rod, or with the edge of the lid instead of with a strabismus hook. The movements should be both circular and radiating, and the pressure employed should be sufficient to produce changes in the epithelium without at the same time injuring the zonule. The operation is not always satisfactory in its results, since it sometimes leads to a considerable thickening of the capsule. Capsular impaction after the extraction of the cataract seems to occur with unusual frequency after this operation has been performed.

Homer Smith's Operation.—A long crucial incision is made through the anterior layer of the capsule with a special knife-needle. The knife-needle has a cutting edge 2 mm. in length. The lens is removed a few hours after the capsulotomy has been performed. The capsulotomy appears to be followed by the formation of a thin layer of

fluid between the capsule and the extremities of the lens fibres.

Operations for the induction of maturity may give excellent results in some cases; but it is rather doubtful whether they are ever really necessary, and the same purpose can often be served by a measure which is attended with less risk.

Very immature lenses of certain types can be extracted without danger, provided that the operation is entirely free from sepsis. An iridectomy, performed some weeks before extraction, will often hasten maturity, and, even if it does not do so, will lessen the risk of any complication after the extraction of an immature lens. In special cases the removal of the lens in its capsule may prove to be the best means of dealing with an immature cataract.

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CHAPTER XIII

SURGICAL TREATMENT OF SOFT CATARACT

Discission—After-complications—Linear extraction—Complications.

The surgical treatment of cataract in persons, whose age is such that their lens nucleus is of a negligible size, will necessarily differ from that required when the lens contains a hard nucleus which is able to resist absorption. In the one case it will be possible either to induce absorption of the lens fibres by allowing the aqueous access to the lens substance through a breach in the capsule, or to remove the soft lens matter through a small opening in the cornea, or through the tissues at the corneo-scleral margin; in the other case, it is necessary to make an opening in the eyeball of sufficient size to permit the passage of the rigid nucleus.

A cataract is said to be *soft*, if its nucleus has not developed in size and density beyond the stage at which it can be readily absorbed by the action of the aqueous humour; such a condition may be expected to exist if the age of the patient, suffering from cataract, does not exceed 20 years, but if greater than this, it will probably be necessary to extract the nucleus of the cataract through a section, the size of which will be in direct proportion to the age of the patient.

A soft cataract may be dealt with either by *discission* or by *linear extraction*. Discission has the advantage that it inflicts the minimum amount of trauma consistent with bringing about the disappearance of the lens matter; but it has the disadvantages that the treatment may extend over a long period, and that more than one opera-

tion may be required. When linear extraction is performed, the treatment is ordinarily much shorter; but, since the disturbance of the ocular tissues is greater, there is more risk of complications and inflammatory changes than in the case of a simple discission. The writer prefers, as a general rule, to perform a discission operation if the patient's age is under 16, and to do a linear extraction if the age is over 16 and does not exceed 28.

Discission.—The eye is prepared as for a major operation, and the pupil is dilated by atropine. The operation may be performed under local anæsthesia if the patient has sufficient self-control to allow of it; but, if there is any doubt upon this point, it is wiser to administer a general anæsthetic. A speculum is introduced, and the eyeball is fixed by grasping the conjunctiva with a pair of fixation forceps, which are applied close to the limbus, either on the nasal side or below. A Bowman's needle, or a needle of a similar type (Fig. 23), is passed subconjunctivally through the limbus, or through the corneal margin, and made to emerge in the anterior chamber; the point is passed across the chamber until it reaches the centre of the pupil, when a small vertical incision, about 3 mm. long, is made through the capsule; this is then crossed by a similar incision, made in the horizontal direction, and the needle is gently withdrawn. Care should be taken to hold the needle as lightly as possible, and to make all movements with the fingers only; when the needle is being withdrawn, it should not be grasped between the fingers and thumb, but merely allowed to lie upon the fingers and to make its own way out of the eyeball; any unnecessary violence will be shown by an escape of aqueous from the chamber. If the needle is withdrawn in the same axis as that in which it was introduced, the shaft will not become "seized" between the layers of the cornea. At the first discission it is advisable only to cut the capsule and not to disturb the lens fibres, there will thus be less danger of excessive swelling of the lens substance. Atropine is instilled, and the eye is bandaged on the completion of the operation. The pupil should be kept well dilated with atropine for

some time after the operation, in order to avoid the formation of any synechiæ. The operation may be followed by a second discission as soon as the eye has become quiet and free from congestion ; a free laceration of the capsule and tearing of the lens fibres may be made at this or at any consequent discission operation.

Iritis is not likely to occur if proper attention is paid to asepsis ; but, if it should do so, it must be treated upon the ordinary lines (p. 139).

A *high tension* after the operation may be the result of a diminution of the angle of the anterior chamber, caused by the iris having been pushed forward by swollen lens matter ; this is unlikely to occur, if, at the first discission, the tear in the capsule is limited to the size suggested, but, should it make its appearance, it will be necessary to evacuate the swollen lens fragments without delay by performing linear extraction.

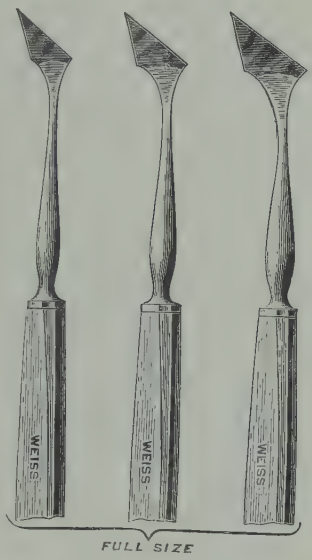

Fig. 67.—Keratome.

Linear Extraction.—The eye is prepared in the usual manner as for a major operation upon the eyeball, and the pupil is dilated by atropine. Local anæsthesia will be sufficient as a rule ; but it is advisable to administer a general anæsthetic if the self-control of the patient is a doubtful quantity. The speculum is introduced and the eyeball fixed as described in the operation for discission. A *keratome* (Fig. 67) is now taken, and its point is rested in position on the cornea at a place which corresponds to the junction of the upper third with the lower two-thirds of a line joining the centre of the cornea with the upper part of the limbus ; the blade is turned so as to lie at right angles to the plane of the ring formed by the limbus, and is gently passed downwards and forwards into the anterior

chamber. If it is intended to combine a capsulotomy with the section, the point of the keratome is made to lacerate the capsule freely, and the instrument is then gently withdrawn in exactly the same plane as it entered ; a slight movement to each side may be made during the withdrawal, in order to enlarge the section, if this is thought necessary. If a capsulotomy is not desired at this stage, the point of the keratome, after entering the chamber, is turned forward, so that the blade of the instrument lies in a plane parallel to that of the iris, and is pushed onwards until the section is of the required size ; it is then withdrawn as described above. Many surgeons prefer to enter the keratome at the limbus ; this has the advantage that the resulting scar is invisible, but an iris prolapse is more likely to occur if the section is placed in this situation ; if the keratome is passed in the proper plane, and does not split the substance of the cornea, the scar which follows a corneal section is very slight, and can only be detected by a careful examination. If a capsulotomy has not been performed previously, the next step in the operation is to tear the capsule with a cystitome. A cystitome, held in such a way that its point is turned to one side, is passed through the wound into the anterior chamber ; when the point has reached the level of the centre of the pupil, it is turned so as to lie upon the anterior capsule of the lens ; a free crucial incision is now made into the capsule, and some disturbance of the lens fibres is effected at the same time ; the point of the cystitome is then again turned to one side, and the instrument is withdrawn.

The lens substance can be evacuated by making light pressure upon the upper lip of the section with a curette, and by alternating this pressure with light massage of the cornea towards the wound ; the use of the irrigator is, however, by far the most efficient means of effecting this object. A stream of warm normal saline solution is directed from the nozzle of the irrigator through the wound into the anterior chamber, and the soft lens matter is speedily washed out of the eye by it ; any resistant masses

can be dislodged by a light massage of the corneal surface, made by the tip of the nozzle ; they are easily washed out of the chamber when the irrigator stream is again directed through the wound.

Complications.—Presentation of vitreous or escape of vitreous is the complication which is most to be feared during the performance of the operation. Eyes which are affected by soft cataract are sometimes the subject of changes in the zonule, capsule, and vitreous ; these may favour vitreous loss. The deleterious effects of such a loss are likely to be aggravated by an associated lack of vitality of the ocular tissues in these cases ; care must, therefore, be taken to exercise great gentleness when removing the lens matter, and should portions of this prove exceptionally resistant, it is more advisable to leave them to become absorbed by the action of the aqueous than to incur a risk of vitreous disturbance in an unhealthy eye. The appearance of a very black, jet-like spot in the pupillary area should be regarded as a signal of serious danger, and the operation should be brought to a conclusion at once.

On completion of the operation atropine is instilled, and the eye is bandaged. It is in most cases advisable to keep both eyes bandaged for the first twenty-four hours after operation ; the affected eye usually can be released and a shade worn on the fourth or fifth day. The eye should be kept under the influence of atropine for four or five weeks after operation.

Iritis is unlikely to occur if the operation has been free from complication, and if attention has been paid to asepsis ; if it should appear, it may be treated in the same way as when it follows the extraction of a senile cataract (p. 139).

CHAPTER XIV

AFTER-CATARACT

Types of after-cataract—Treatment of after-cataract—Dangers of operation—Irido-cyclitis—Glaucoma—Interval between extraction of cataract and needling—Preparations for operation—Description of operation—Iridotomy—de Wecker's operation—Ziegler's operation.

An after-cataract is an opaque, or partly opaque, membrane, which, lying in the place previously occupied by the lens, obstructs the pupillary area. Such a membrane may be due to one or more of three causes—(1) The organisation of an inflammatory exudation; (2) the incomplete absorption of lens matter or blood-clot, left in the eye at the time of operation; (3) the proliferation of capsular cells; (4) the wrinkling of the posterior layer of the lens capsule.

The organisation of an inflammatory exudate is by far the commonest cause of after-cataract. The density of the cataract will be in direct proportion to the intensity of the inflammation, and will vary in degree from a very delicate film to a thick, grey, or white, membrane, to which the iris is firmly adherent. In cases where a severe infection has existed, the pupil is often entirely blocked, and it is sometimes completely drawn up into the neighbourhood of the scar by the contraction of the organised inflammatory tissue. Any blood-clot and cortical remnants, left in the chamber at the time of operation, will have an influence in increasing the intensity of the inflammation, and will also form a framework on which inflammatory cells can build a membrane, even when the virulence and dosage of the infection are low.

The capsule of the lens also may sometimes form a scaffolding upon which inflammatory cells can collect and organise an opaque membrane.

An after-cataract is sometimes found even when the lens has been completely removed in its capsule. If such a cataract is not due to an inflammation caused by an infection at the time of operation, it is usually the result of a contact, during healing, between the vitreous and the wound, by which cells are enabled to make their way from the edges of the latter into the interior of the eyeball. In such cases a very fine membrane can often be seen to run from the deep surface of the scar into the vitreous.

The incomplete absorption of cortical matter, in an eye free from infection, is favoured by an imperfect capsulotomy. If the opening in the capsule is small, and is such that the edges of the rent in its anterior layer can come into contact with the posterior layer, free access of the aqueous to any remaining lens matter, thus shut off, may be prevented, and absorption of this may be hindered. Treacher Collins has drawn attention to the necessity of securing as large an aperture as possible in the anterior capsule, in order to avoid the formation of after-cataract from this cause.

The retention of cortical matter between the layers of the capsule may stimulate the capsular cells to proliferate, and vesicular cells and hyaline thickenings may thus be formed as in the case of an anterior polar cataract (p. 29). Cortical matter, retained in the eye, does not, as a rule, lead to the formation of a permanent after-cataract, unless it is accompanied by infection, or unless it has become shut off in a capsular pocket in the manner described.

The proliferation of capsular cells (Fig. 68).—An after-cataract from this cause may in some cases be due to the thickened and opaque capsule of a hypermature cataract being left in the pupillary area at the time of operation. It most commonly occurs, however, some months after the removal of the lens. The patient, who has seen well after the operation, finds that, in the course of a year or so, his

vision is again failing. Focal illumination and the use of a loupe will show a very fine, delicate, cobweb-like membrane in the pupil. The structure of this is best seen by direct ophthalmoscopic examination with an electric ophthalmoscope, in the sight-hole of which is placed a high convex lens. Herbert has described the condition found. Tiny black circles are seen against the red reflex. These form masses in places, and rather resemble a thin film of soap lather. The membrane is seldom thick; but it may interfere with vision considerably. It is difficult to suggest any reason why such a capsular proliferation should occur in some cases and not in others; but it seems to be most frequent in those where the capsular rent is

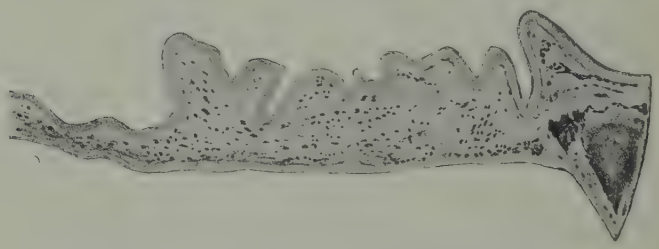

Fig. 68.—After-Cataract. New tissue laid down between the layers of the capsule.

(From Parsons' *Pathology of the Eye.*)

small. It is found in eyes which have healed without any noticeable reaction just as much as in those which have suffered from post-operative complications. It is likely that the condition may sometimes represent an attempt, on the part of the capsular epithelium, to regenerate the lens substance. Possibly, contact with the posterior layer of the capsule may sometimes stimulate the capsular cells to proliferate. The growth of cells is not always limited to the anterior part of the capsule; but the cells, which line this portion of the membrane, may spread on to the posterior layer, and may furnish it with an opaque lining.

A wrinkling of the capsule may occasionally bring about a loss of vision after a cataract extraction. The cause of the condition is not very clear, but it is probably pre-

disposed to if a disturbance of the capsular attachments should occur in the course of a difficult delivery of the lens nucleus. A section of insufficient size, and a faulty direction of the pressure, made to deliver the nucleus, may thus be factors in its causation.

Treatment of After-Cataract

The method of treating after-cataract is to form an aperture in the opaque membrane, through which light can pass. In rare instances, when the thickening of the capsule is great, and when the membrane has few, if any, adhesions to the iris, it may be advisable to remove it with forceps, which are introduced into the chamber through an incision in the cornea or limbus. Capsular thickenings of this type are usually due to hypermaturity of the cataract, and were present before the lens was extracted.

The dangers attached to an operation are—(1) That it may set up an inflammation of the iris or ciliary body, and (2) that it may be followed by glaucoma.

Inflammation may result from an operative infection, or from the infliction, during the operation, of such an injury to the iris or ciliary processes as would permit the recrudescence of an infection which had become latent. An injury of this nature may be due to a failure to use the cutting edge of the instrument, when dividing the membrane.

A later inflammation may be caused by the inclusion of some vitreous between the edges of the wound. A path is thus formed along which infective organisms can reach the deeper parts of the eye. Such an inclusion (1) may occur if the anterior chamber is emptied during "needling," so that the vitreous can come forward and follow the instrument as it is withdrawn from the wound, or (2) may result from a serious disturbance of the vitreous in the course of the operation.

Glaucoma may be caused by a displacement of some vitreous into the anterior chamber. The displaced vitreous

may obstruct the channels of filtration, or, if it passes forwards to the wound, as the instrument is being withdrawn from the eye, it may form an attachment to the site of puncture, drag forward the iris, and so narrow the angle of filtration. Such an accident is predisposed to if a knife or needle is made to "plough" the anterior portion of the vitreous, and if the anterior chamber is emptied by faulty movements of the instrument. The iris may, in rare cases, be dragged forward, in a similar manner, by the adhesion of a portion of the membrane to the wound. It has been suggested that an advance of the front part of the vitreous body may in some cases be the cause of a rise in tension. The advance of the vitreous follows a rupture of the anterior layers of the hyaloid during the operation.

A high tension may sometimes be due to the occurrence of an irido-cyclitis, which has caused a blockage of the channels of filtration.

The time allowed to elapse after an extraction, before an operation for after-cataract is performed, varies considerably in the practice of different surgeons. Most prefer to wait until the edges of the wound are fairly firmly united, and until the eye is quite free from all sign of vascular congestion, conditions which are not likely to be present before the expiration of 6 weeks. Some eminent surgeons, however, do not hesitate to operate much earlier, and Herbert has made a practice of "needling" the after-cataract 10 or 11 days subsequent to the extraction. He points out that a secondary membrane, at this period, is easy to divide, and that the capsule has not lost its elasticity, so that the edges of an opening in it are likely to retract widely.

Whatever opinion may be held with regard to the time at which the operation should be performed, it is certain that it should not be undertaken if any signs of inflammation of the iris or ciliary are present.

The technique of different surgeons varies with respect to the instrument used to make an aperture in the membrane, and with respect to the method of its employment.

The following instruments are in common use: Bowman's needle (Fig. 23), Knapp's knife-needle (Fig. 69), Ziegler's knife-needle (Fig. 70), and a Graefe knife with a very narrow blade. The requirements of a knife-needle are that its blade and point should be exceedingly sharp, and that it should have a smooth, rounded shank which exactly fills the wound, so that an escape of aqueous is prevented, whilst strain upon the lips of the aperture is avoided. The delicacy of such an instrument, and the difficulty experienced in keeping it in proper condition are serious objections to its use by surgeons working in remote parts, and for this reason many prefer to employ a narrow-bladed Graefe knife; the use of this, however, requires some care, since the wound may be enlarged by the heel of the knife, whilst the attention of the surgeon is occupied by the movements of its point. A Bowman's needle should have a broad head furnished with very sharp cutting edges; the shank of the instrument should exactly fill the aperture made by its head.

Fig. 69.—Knapp's Knife-needle.

Fig. 70.—Ziegler's Knife-needle.

The majority of surgeons now enter the instrument at or near the limbus, and many pass its point beneath the conjunctiva before it enters the limbal tissue. This site is chosen for three reasons—(1) It is less likely to be followed by infection, since, if a thread of vitreous should pursue the instrument as it is withdrawn from the eye, the extremity of this thread will be covered by the vascular tissue of the limbus, and will thus be protected from microbic invasion. Such a protection will be more complete if the puncture is a subconjunctival one. A wound, too, which is made in the limbus, passes obliquely through the tissues, so that the opening has a valvular character,

and leakage of the aqueous is unlikely to occur through it. (2) As shown by Jackson, an instrument, entered at the limbus, is allowed a far wider range of movement than one which is entered in a more central position. (3) Should a capsular adhesion occur, the further forward on the cornea the site of its attachment lies, the more likely it is to cause glaucoma (Treacher Collins).

Preparations for Operation.—The eye should be prepared as for a cataract extraction, and the pupil should be dilated by atropine. Good illumination is absolutely essential, and some form of artificial light is required. The parabolic torch lamp (p. 99) will usually be found to be quite satisfactory. The character of the membrane should be studied, and a suitable method of dealing with it decided upon. A Knapp's knife-needle is to be preferred when the cataract is thin and yielding, and a Ziegler's knife-needle, with a falciform edge, when it is more dense. In cases of very dense after-cataract Bowman's operation with two needles may prove to be the most suitable.

Operation.—The speculum is introduced and the conjunctiva seized by a fixation forceps. The knife-needle is entered with the plane of its blade parallel to that of the iris ; it is passed across the chamber until its point reaches the opposite margin of the pupil, and is then turned so that its edge faces the membrane. The knife is next thrust through a thin portion of the cataract, and the membrane is divided by a sawing motion of the blade. A single cut may be sufficient to form a good aperture, but, if it is not, a V-shaped, or a T-shaped, or a crucial incision may be made. Care should be taken to avoid all irregular prising movements, such as would lead to an escape of aqueous, and to cut the membrane without dragging upon its attachments to the ciliary processes. The instrument should be held very lightly, and the pressure of its cutting edge upon the vitreous should be as light as is consistent with the division of the membrane. When a sufficient aperture has been formed, the blade of the knife is again turned so that its plane lies parallel to that of the iris, and the in-

strument is withdrawn in exactly the same axis as it was entered. Atropine is instilled, and the eye is bandaged. It is unnecessary to occlude the unaffected eye, if the operation has been quite free from complication, and if no aqueous has been lost. The bandage may usually be removed on the third day.

Should the after-cataract be very dense and tough, a discission operation with two needles, of the type described by Bowman, may prove to be the most satisfactory. One Bowman's needle is entered in the limbus at one extremity of the horizontal diameter of the cornea, and another at the other extremity of the same meridian. The cutting edges of the needles are turned towards the membrane, and the point of one of them is made to pierce the after-cataract. The point of the second needle is then passed through the membrane alongside the first, and the two are widely separated by moving their handles towards each other. Care should be taken to pivot the movement on the site of the limbal puncture, but to throw no strain upon the latter by making irregular or prising movements such as would lead to a loss of aqueous. As the points of the needles diverge, the membrane is divided by the cutting edges of the instruments. A very tough membrane can be divided in this way without causing any strain on the ciliary processes, since any pull upon them is taken up by the needles.

The writer has frequently treated a thin membrane by puncturing it with a Bowman's needle, which is introduced near a point situated midway between the centre and the periphery of the cornea. The patient is made to look upwards, and a Bowman's needle, which has a fairly broad head and a very sharp cutting edge, is entered through the cornea at a point about $2\frac{1}{2}$ mm. from its centre. The needle is directed towards the centre of the pupil, and great care should be taken to ensure that it is quite dry, and that no fluid can run down its shaft from the fingers of the surgeon. A succession of punctures are then made through the delicate membrane at the place chosen for the aperture; these coalesce with each other and form a good opening. It

is important to puncture the membrane cleanly, and to avoid any endeavour to tear it or to "stir it up."

The proportion of cases of after-cataract which require a capsulotomy will vary considerably in the practice of different surgeons—2416 patients were operated upon for senile cataract in the Madras Government Ophthalmic Hospital during the years 1916 and 1917, whilst only sixty-one (or 2·5 per cent.) needlings for after-cataract were performed during the same period. The greater number of patients treated at this institution are uneducated, and do not demand a very high standard of visual acuity. When dealing with educated patients, many of whom are dependent for their living upon work which requires good sight, from 20 per cent. to 40 per cent. at least may be estimated to need a capsulotomy operation.

Iridotomy.—When a severe inflammation has been present, and has caused the formation of a very dense membrane to which the iris is firmly adherent, and when the obstructed pupil has been thus drawn up into the operation scar, it will be necessary to form an aperture in the iris, through which vision may be possible. The types of operation suggested by de Wecker, or that devised by Ziegler, are probably the ones which are most used.

In de Wecker's operation a keratome is entered at the upper part of the cornea, and its point is thrust through the iris just beyond the place where this joins the membrane occupying the pupillary area. The keratome is withdrawn, and the pointed blade of a de Wecker's scissors is passed through the aperture and down behind the diaphragm, formed by the iris and organised inflammatory tissue. After dividing the tissue, the scissors are partly withdrawn, and are then again passed downwards, in a direction which diverges from that of the first incision, and a second cut is made through the iris. A V-shaped cut is thus made through the diaphragm, the apex of the V lying at the point where the keratome pierced the tissue. The base of the flap usually retracts quite readily; but, if it should not do so, it may be pushed down by the point of the closed scissors. A slight modification of this operation may be

made by causing the keratome to form a wide cut in the membrane, and to make two converging snips with the scissors from each extremity of this incision. A triangular area, whose base lies upwards, is thus isolated, and can be removed with a forceps. Ziegler gives the following account of the operation of iridotomy as performed by him :

"*First stage.*—With the blade turned on the flat the knife-needle is entered with a quick puncture at the upper sclero-corneal junction, passed across the anterior chamber almost to the lower margin, rotated edge down and swung 3 mm. to the left of the vertical plane. With the point resting on the membrane a quick, dart-like thrust is made through it ; then, without making pressure on the iris tissue, the knife is gently drawn up and down with a saw-like motion until the incision is carried upward to near the point of corneal puncture, always maintaining the movement in a line with the axis of the knife.

"*Second Stage.*—The primary incision will now bulge open into a long oval, through which the knife blade should be raised up into the anterior chamber and swung across 4 mm. to the right of the vertical plane (the extra millimetre usually compensates for retraction of the membrane when cut). Again resting the knife point on the membrane the same quick thrust is made, and the second incision carried up by a sawing movement to a point just inside the extremity of the first incision, thus completing a converging V-shaped cut. Here pressure must especially be avoided or the last fibre will not be severed. When the incision is completed the triangular flap should automatically roll back, like a curtain. The knife is then turned on the flat and quickly withdrawn.

"The corneal puncture should now be curetted lightly with an iris spatula or the back of a knife to remove any lacerated tissue or film of capsule that might have been carried up by the knife blade. This helps to prevent infection of the wound and after-scarring of the cornea."

Ziegler emphasises the importance of placing the counter-puncture through the membrane at a sufficient distance from the puncture in the cornea, of avoiding any pressure

upon the iris tissue, and of making allowance for retraction of the membrane before locating the second iris puncture.

Ziegler employs exactly the same technique for the execution of a V-shaped capsulotomy.

The writer has satisfactorily dealt with cases of closed and drawn-up pupil after cataract extraction by using a narrow-bladed Graefe knife. The knife is entered at the limbus, as in the case of a cataract extraction, and is passed across the chamber until it reaches a point about 2 mm. to the inner side of the lower end of the vertical meridian of the cornea. It is then thrust through the iris and any membrane lying behind the iris, and these structures are divided by the cutting edge as far as the margin of the drawn-up pupil. Care is taken to cut in the plane of the blade, so as to pull on the tissues as little as possible. The incision in the membrane usually gapes widely and forms a slit-like pupil; but, if it does not do so, a forceps is introduced through the wound made by the knife, and the margin of the cut iris is gently withdrawn and a portion excised.

An iridotomy should not be attempted for some weeks after all signs of inflammation have disappeared from the eye.

Although it is inadvisable to operate before the eye has become quite quiet, yet the iridotomy should not be delayed until the membrane has become tough, the tension has become very low, and degenerative changes have set in.

An iridotomy may be followed by some hæmorrhage from the divided tissues, and it is useful to apply leeches to the temple immediately the operation has been completed, in order to anticipate the occurrence of this complication.

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CHAPTER XV

COMPLICATED CATARACT

Intra-ocular tumours—Retinal detachment—Cataracta accreta—Anterior and posterior cortical cataracts—Glaucoma—Treatment of complicated cataract—Wenzel's operation.

A COMPLICATED cataract is one in which the beneficial effect of the removal of the lens is likely to be diminished or to be completely nullified by the existence of some other disease of the eye. The associated disease is frequently the cause of the lens opacity.

Intra-ocular tumours and retinal detachments cause a cataract by an interference with the lens nutrition ; this is often brought about by a contact between the lens capsule and the vascular tissue of which they are composed. Interference with the functions of the capsule is also caused by the formation upon it of inflammatory membranes due to iritis and to cyclitis. In this case the uveal tissue and the lens capsule may be bound together, and a "cataracta accreta" may be formed. Such cataracts frequently undergo calcareous changes.

Lens opacities may also be produced by alterations in the nutritive fluid which result from disease of the neighbouring structures. Anterior and posterior cortical cataracts may thus be caused by an interference with the nutrition of the lens fibres, due to inflammatory or degenerative changes in the choroid and retina. Glaucoma, as might be expected from the general disturbance of the ocular nutrition which occurs in the disease, frequently causes the formation of lenticular opacities.

The treatment of a complicated cataract will depend upon the amount of injury that the perceptive elements of the eye have sustained, and upon the presence or absence of active inflammatory changes or of a high ocular tension. If a careful examination of the projection shows that little or no sight is likely to be obtained after removal of the lens, it will be inadvisable to submit the patient to the strain of an operation. When the intra-ocular pressure is high, and the projection is good, the tension should first be reduced by a trephining or by an iridectomy, and the extraction of the lens should be undertaken later. No good result is likely to follow the removal of the lens from a glaucomatous eye until the glaucoma has first been treated and relieved.

It might be thought that the removal of the lens from a glaucomatous eye would probably lower the ocular tension by increasing the area available for filtration ; but such is not the case. Not only are complications likely to occur during the performance of the operation, but the disturbance of the parts, which an extraction of the lens involves, and the presence of lens remnants in the eye, are likely to cause a continuance of, and often an increase in, the glaucomatous condition, if this has not been previously remedied.

Glaucoma, which is due to the development of a senile cataract, is seen fairly frequently in India. The cataract in such cases is of the swelling and liquefying type ; the interference with the channels of filtration, which such a swollen lens causes by its encroachment upon the circumlental space and by its advancement of the iris, can be readily understood. Such glaucoma is always of an acute congestive type, and is usually accompanied by severe pain in the eye and in the head. The steamy cornea, shallow anterior chamber, semidilated and inactive pupil, through which the swollen opaque lens can be seen, are very characteristic, and the diagnosis of the disease can often be made before the tension of the eye has been examined. The condition can be differentiated from a cataract, which has occurred in the course of glaucoma—(1) By

the history of the case; (2) by the presence of an uncomplicated cataract in the other eye; (3) by the absence of any atrophic change in the iris, such as would be likely to have taken place in a primary glaucoma of long standing.

These cases are best treated by postponing all operative measures until an attempt has been made to reduce the tension by medicinal means. Frequent instillations of eserine should be made into the eye, leeches applied to the temple, a brisk saline purgative administered, and some hours' sound sleep ensured by a suitable dose of morphia. The glaucoma may disappear completely after a few hours' treatment on these lines. It is usually advisable, however, not to remove the lens immediately, but to perform a preliminary iridectomy first. It is an interesting fact that a fall in the ocular tension is often followed by a considerable absorption of the fluid of a Morgagnian cataract.

Cataracts which are complicated by the presence of products of inflammation on the lens capsule are usually best dealt with by performing a preliminary iridectomy. The reaction of the eye to trauma can be tested by this operation, and the nature of any inflammatory membrane can be investigated. Less injury also is likely to be inflicted on the eye when extracting the lens subsequently. Owing to extensive adhesions, it may be impossible to perform a satisfactory iridectomy, and, when this is so, it may be necessary to divide the iris and the membrane with the blade of the knife when making the section at the time of the operation for the removal of the lens (Wenzel); the iris and the attached inflammatory tissue can then be cut away with a de Wecker's scissors. Difficulty will often be experienced in dividing the lens capsule in cases of cataract, which are complicated by the previous occurrence of iridocyclitis, and it may be necessary to pass the knife into the wound, and to use it to cut the tough membrane. The thickened and opaque capsule can often be removed after the delivery of the lens by grasping it with a forceps; if it resists delivery in such a fashion it is wiser

to leave it in place, and to make an aperture in it at a subsequent operation. In the after-treatment of all these cases it is advisable to act as if they were suffering from iritis, and to apply leeches, to use atropine freely, and to administer mercurials and aspirin.

CHAPTER XVI

RESULTS

Statistics—Disadvantages of aphakia—Pseudo-accommodation for near objects—Post-operative astigmatism.

The study, for purposes of comparison, of statistics of the results obtained by different surgeons in the operation for cataract, is, as a rule, somewhat unsatisfactory. The reasons for this are—(1) That the same standard is not adopted in every case, and (2) that the period at which the vision is recorded is very variable. An eye, which has healed well without the development of any complication, is, in Indian practice, usually tested on the tenth day, or thereabouts, after operation. The vision of an eye, tested at this early date, may easily appear inferior to that of another eye, recorded at a later date after a prolonged treatment for serious complications during healing. Yet, if the standard adopted by every surgeon was the same, reasonably fair comparative estimates might be made, since although some of the eyes, which showed good visual results at first, may deteriorate later, this will be compensated for, as regards the statistics, by the improvement of others whose early vision was not so good. The writer has been accustomed to adopt a standard similar to that of Jessop, and to record those operations as "successes" in which the vision is $\frac{6}{36}$ and better, as "partial successes" those between $\frac{2}{60}$ and $\frac{6}{60}$, and as "failures" those below $\frac{2}{60}$. The standard of success demanded by the patient will be an acuity of vision which allows him to perform his work efficiently, and this will be a slightly

variable one, since much will depend upon the nature of the work.

Casey Wood considers that 70 per cent. of patients operated upon should have good vision, with ability to read ordinary print and to follow the occupations proper to their age and station in life. He allows for a complete failure in 3 per cent., and for a vision of less than $\frac{6}{60}$ in another 7 per cent. This estimate appears to be a very fair one as regards the poor results, but to place the good results at too low a figure.

It will be necessary for a patient, who has been operated upon for cataract, to wear a suitable lens in order to see clearly with the aphakic eye. If the eye was previously emmetropic, a convex lens of 10 dioptres will ordinarily be required to see distant objects, and one of 14 dioptres to read fine print at a distance of 25 cms. A reading lens of 13 dioptres will, however, often prove more comfortable for the patient to wear, even though he may be unable to see quite as small type with it.

Patients, who were previously hypermetropic, will require a lens of proportionately greater convexity, and those who were myopic one of less convexity, than those who were emmetropic. A patient, who had a myopia of 10 dioptres, usually shows some hypermetropia when rendered aphakic. When this occurs, it is due to some of his former myopia having been lenticular ; obviously, only that portion of it which was axial can be effective in reducing the amount of aphakic hypermetropia.

An aphakic patient, who requires to wear a powerful convex glass, is placed at a disadvantage in some respects :

1. He has an exceedingly limited range of focus, and only possesses clear vision for objects which are situated at the point for which his glasses are suited. His distant correction will, therefore, only permit distinct definition of objects lying further away than a point about 5 metres from the eye, and those objects, which are nearer than this, will not be seen clearly. His correction for near objects will allow clear definition at one point, but anything, which is nearer or is further away than this, will not be

properly seen. Some range of focus may be obtained, however, if the patient alters the position of the lens in front of his eye, and he may be instructed to slide his distance glasses down his nose when he wishes to see an object at an intermediate point.

2. Owing to the strength of the lens employed, clear vision will only be possible if the patient looks through the centre of the lens. He will therefore be unable, by rotating his eye, to see clearly objects which lie to his side, and it will be necessary for him to turn his head towards any object that he may desire to study. It is advisable to inform patients of this fact.

It is not usually advantageous for patients, who have been operated upon for cataract, to wear bifocal lenses, since, if they do so, difficulty may be experienced when walking on an uneven surface. Bifocal lenses may, however, be of service in exceptional cases, especially if they are only worn in the office or in the home. If only one eye is used, and if that eye is aphakic, it will often be convenient to have the spectacle frame fitted with side-pieces hinged in such a way that the frame can be reversed ; one eye of the frame is fitted with the correction worn for distant vision, and the other with that for reading. By reversing the side-pieces the lens required at the time can be placed in front of the eye, and the patient is thus saved the necessity of carrying two pairs of glasses. In other cases it may often be helpful to carry convex lenses, of 3 or 4 dioptres, mounted in a lorgnette ; this can be held in front of the distant correction when it is desired to focus a near object.

Cataract glasses, of the common type, are both heavy and ugly, and patients will often appreciate lighter lenses, such as those of the " luxe " pattern.

It is hardly necessary to state that, if the patient wears a high convex lens in front of each eye, and has binocular vision, care must be taken that the frames are properly constructed, and that the lenses are accurately centred. If this precaution is not taken, great trouble may be experienced from the very considerable prismatic effect

caused by the centre of a high-powered lens being out of the visual axis.

An aphakic patient will very rarely show some ability to exercise a *pseudo-accommodation* for near objects, and this may even be sufficient to permit him to read small type with the same glasses with which he can clearly see distant objects. The explanation of such a phenomenon is somewhat difficult, and the cause of it is possibly not the same in every case. A small and active pupil, or a small central aperture in a dense capsular membrane, will sometimes, by cutting off the more divergent rays, allow of a limited adjustment of focus for near objects. In some cases a pressure of the ocular muscles upon the globe may perhaps cause a lengthening of the antero-posterior axis of the eyeball. Park Lewis has suggested that a portion of the vitreous body may be forced forward through a capsular aperture by compression, and, owing to the convexity of its surface, may act in a similar fashion to the lens.

Astigmatism.—When the extent to which the anterior segment of the eyeball is interfered with during a cataract operation is considered, it is no matter for surprise that the proceeding is often followed by some astigmatism. The astigmatism is nearly always "against the rule," and the axis of the correcting cylinder will lie in the horizontal direction, its extremities corresponding to the sites of puncture and counter-puncture. Astigmatism is most marked soon after the operation, and it usually decreases considerably during the ensuing months, and, in favourable cases, disappears completely after about a year. E. Jackson found that in 60 per cent. of a series of cases the astigmatism lessened up to the end of the third month, and that only a slight diminution occurred later; in 20 per cent. the changes continued after the third month. He concludes that "after a certain period, limited apparently to the first year, or possibly a little longer, the amount of astigmatism becomes quite fixed, and is as little liable to change as in cases of moderate astigmatism not due to operation." The astigmatism is due to an alteration in the curvature of the cornea, which is caused by the flap

being pushed forward by the ocular fluid when the anterior chamber reforms. The flap is roughly semicircular, and, being firmly fixed on each side, where the puncture and the counter-puncture were made, is thrust forward in such a way that the curve of its transverse diameter is greater than that of its vertical diameter. The amount of the astigmatism will be greatly influenced by the character of the section, and by the impaction of any tissue in the wound. Herbert states that "in sclero-corneal sections the downgrowth of episcleral tissue interposes a wedge between the wound surfaces, keeping them apart. Hence the permanent element in the abnormal curvature is commonly greater in sclero-corneal than in purely corneal incisions." He also says that the astigmatism resulting from a corneal section is apt to be greater the nearer the section is to the centre of the cornea.

An irregular and badly made section is much more likely to be followed by astigmatism than one which is well made, and which allows the edges of the wound to lie in proper apposition. A section which lies partly in the cornea and partly in the sclera is more likely to cause an uneven cicatrisation than one which is placed at the corneo-scleral junction. An imperfect adaptation of the edges of the wound, accompanied by an overlapping, may cause a considerable degree of astigmatism. A prolapse of the iris, or of capsule, or of vitreous, between the lips of the section, will often be followed by a high degree of astigmatism. These causes act, not only by separating the edges of the section, but also by inducing the formation of an excessive amount of inflammatory tissue which is likely to contract irregularly as it cicatrises.

A vitreous prolapse, which occurs during the first week after operation, may cause great astigmatism. The prolapse is often due to an injury to the eye, and a portion of the vitreous body may be seen to bulge forward from between the lips of the section, and to lead to a wide separation of the edges of the wound. Astigmatism, from these

causes, is likely to diminish considerably in the course of a year, but the permanent amount is usually high.

Although a high degree of permanent astigmatism only occurs in a small percentage of cases after the extraction of a cataract, yet a low degree, of 1 dioptre and less, is very common, and the comfort of the patient may often be greatly increased by its correction. Aphakic patients, who have only been prescribed a spherical correction, often find that their vision is improved if they tilt the lens so as to produce a cylindrical effect ; it is obviously desirable to add a suitable cylinder to the correction of such patients.

Any element of lenticular astigmatism must be absent in an aphakic eye, and it would appear that all the astigmatism which is present must be corneal. The opthalmometer should therefore give an accurate reading of the amount of error present, and of its axis. It is, however, a fact that the patient will seldom accept as high a cylinder as that indicated by the instrument, especially when the abnormal curvature of the cornea is excessive. Elliot has suggested that this may be due to the introduction of another astigmatic element by an alteration in the anterior surface of the vitreous body. The curvature of the anterior surface of the vitreous tends to be greater in its vertical meridian, and, being inverse to the corneal astigmatism, reduces the total error.

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